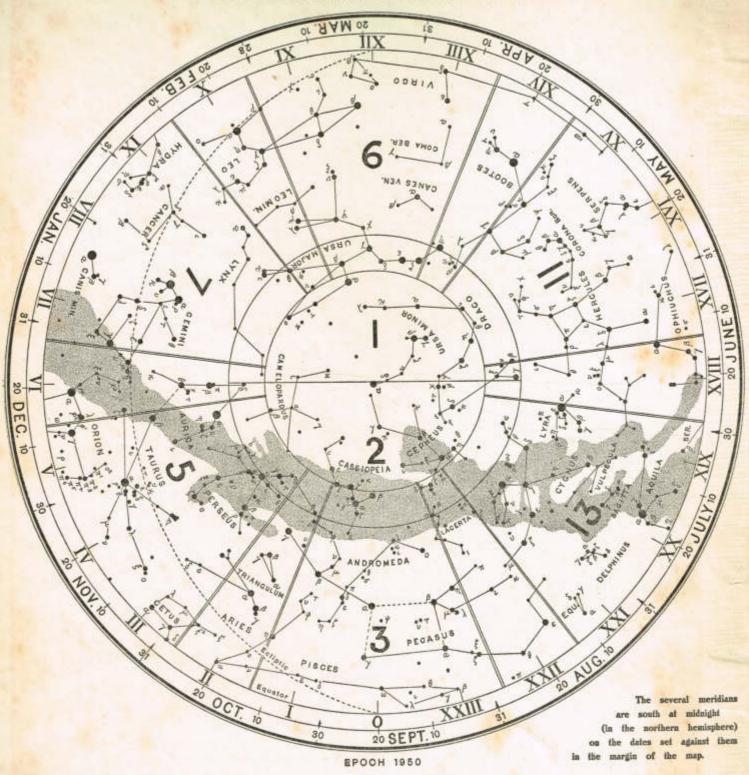# Norton's Star Atlas

and Telescopic Handbook

By Arthur P. Norton, B.A.
AND
J. Gall Inglis, F.R.A.S.

8000 STARS, CLUSTERS, NEBULÆ, &c,
AND LISTS OF 500 INTERESTING OBJECTS

NORTHERN INDEX MAP

EPOCH 1950

The several meridians
are south at midnight
(in the northern hemisphere)
on the dates set against them
in the margin of the map.

Astronomical Symbols (Contractions on p. xvi). $\alpha, \delta, \beta, \lambda$, are also used as inferior indices to other symbols.

α Right Ascension

β Latitude (celestial, geocent.)

δ Declination, $+$N, $-$S.

ϵ Obliquity of Ecliptic

θ Sidereal time: θ_0 at mean midnight

λ Longitude (celestial, geocent.)

λ Wave-length, in Angstroms $= 0\cdot000,000,1$ mm. (p.22)

μ Proper motion (total annual); Eccentric anomaly (or E).

μ Micron, $=1/1000$th mm. $\lambda = 10,000$

$\mu\mu 1/$millionth mm. $= \lambda 10$

ν Frequency

π Parallax, annual, in "; Longitude of perihelion (also $\tilde{\omega}$)

ρ Terrestrial radius

ϕ Geographical latitude : $+$N.; (ϕ' Geocentric); Angle whose sine $=$ eccentricity

ϕ Altitude of N. Pole

χ Ionisation potential

ω Asc. node-perihelion angle

ϖ Longitude of perihelion

Δ Distance fr. Earth, in A.U.; Difference

Σ (or [ ]) symbol of summation

Ω Longitude of ascending node

A Albedo: Amplitude (variable

A or Az Azimuth   [stars]

$C.I.$ Colour index

D Diameter

E Equation of time; Eccentric anomaly; Colour excess

G Gravitational Constant

H or t Hour angle

$H.I.$ Heat Index

I Intensity

L Geograph. longitude, $+$W.

M Magnitude, absolute (indices, p. xvi): Mean anomaly

P Period (orbital)

P_0 Parallax, equat. horizontal

R Refraction: Sun-Earth dist.

S Solar constant

T Time of perihelion passage or transit: Temperature, T_e effective; T_c colour.

V, T, W, Velocity,* radial (receding $+$), tangential, spatial.

X, Y, Z Rectangular co-ordinates

a Semi-major axis of ellipse

b Semi-minor axis ; Heliocentric latitude ; Galactic latitude

d Distance, in seconds of arc

e Eccentricity of orbit

g Acceleration due to gravity

h Altitude

i Inclination of plane of orbit

k Gaussian gravitation constant

l Heliocentric longitude ; Galactic longitude

m Magnitude, apparent (Indices, m_v, $_{pv}$, $_{pg}$ &c., see p. xvi)

m Mass, Sun $= 1$

n Mean angular motion (or μ)

p Annual precession (general)

p Position angle, $0°$-$360°$ (p. 5) ; equat. horizontal parallax

q Perihelion distance

r Radius vector, in A.U.s ; Distance in parsecs

t Time of observation; Hr. angle

t_m „ mean : t_v True time $\dagger$

t_o „ of Epoch

v True anomaly

z Zenith distance (apparent)

* With reference to the Sun. $\dagger$ From Mean or True midnight.

A STAR ATLAS

AND REFERENCE HANDBOOK

(EPOCH 1950)

FOR STUDENTS AND AMATEURS

*Covering the whole Star Sphere, and showing over 9000 Stars, Nebulæ,
and Clusters; with Descriptive Lists of Objects mostly suitable
for Small Telescopes; Notes on Planets,
Star Nomenclature, &c.*

BY

ARTHUR P. NORTON, B.A.

The Reference Handbook by
J. GALL INGLIS, F.R.A.S., AND A. P. NORTON

Contents:

Made and Printed in Great Britain

PREFACE

THE first Edition of this Atlas was published in the year 1910. The work was primarily designed for those amateur telescopists whose instruments are mounted either on alt-azimuth stands or as equatorials without graduated circles. It was also intended to be used as a companion to Webb's invaluable "Celestial Objects for Common Telescopes," and Smyth's admirable "Cycle of Celestial Objects," both now out of print. Practically all the objects contained in the latest editions of these two works, down to and including stars of the seventh magnitude, are shown in the maps, also several fainter objects of particular interest.

Owing to the plan and arrangement of the maps, and also on account of the large overlap, a view of about one-fifth of the entire heavens is shown on one folio, and no constellation is inconveniently broken up. The distortion is slight considering the large area represented. Altogether the charts indicate the positions of over 8,400 stars and 600 nebulæ.

A sketch Map of the Moon, indicating the more important features, and two charts of the Galactic regions, are provided ; the latter, having R.A. and Dec. lines as well as galactic co-ordinates, will be helpful in galactic studies. Bright variable and red stars are indicated by a small "v" and "R" respectively, but double stars could not be similarly lettered without sacrificing the clearness of the maps. For particulars of these objects, reference should be made to the lists on the back of the maps and to "Webb" and "Smyth."

For the 8th Edition the letterpress was re-arranged, and this new order has been retained in the present Edition. First come the various reference lists and tables on pages vi to xvi. These are followed by the sections of the Reference Handbook :—

I. Notes on Star Nomenclature.	v. The Sun, Moon, and Planets ; Celestial Phenomena.
II. Notes on Astronomical Terms.	
III. The Galaxy and the Stars.	vi. Hints on Observing.
IV. Spectroscopy.	vii. The Care and Use of the Telescope.

The underlying idea has been to furnish both the amateur observer and the general reader with a reference book to which he can turn for an explanation of unfamiliar terms—observational terminology especially being very inadequately dealt with in text-books. These explanations are necessarily much compressed, but it is hoped they are sufficiently complete for the required purpose. Sources of fuller information are often given.

The Constellation boundaries used are those prepared by Mons. E. Delporte, and adopted by the International Astronomical Union in 1930. The epoch of Mons. Delporte's boundaries is 1875, and by 1950 the change of their positions in R.A. and Dec., due to 75 years of precession, is appreciable. With respect to the stars themselves the positions of the boundaries always remain unaltered.

The kind and encouraging testimony as to the usefulness of my Star Maps given by professional and amateur astronomers, both at home and abroad, especially in the United States of America, induced me a few years ago to re-draw all the main charts for the new standard epoch 1950. In this Edition, the former Index Maps and Galactic Charts have been replaced by new and more complete ones.

All the main features of the previous maps have been retained, but with certain alterations :—

(a) Stars from the Revised Harvard Photometry down to magnitude 6·35 have been charted. In the original edition of this work, the star places were taken mainly from Houzeau's "Uranométrie Générale." A careful comparison of the magnitudes of Houzeau's fainter naked-eye stars with the same stars included in the H.R. and its Supplement, showed that many of his stars are placed at a lower, sometimes a much lower magnitude than 6·35 on the Harvard scale. Such stars have now generally been omitted. On the other hand, many Harvard stars, not in Houzeau, have been inserted, as well as several additional double stars from various sources.

(b) All nebulæ, except those of Messier and those classed by Herschel (see p. 55), have now received the N.G.C. numbers.

(c) Variable stars which reach at their maximum brightness the 6th or 7th magnitude, have been indicated in the maps by small circles.

(d) The Galactic Equator and Poles now adopted are those recommended by the International Astronomical Union, and differ slightly in position from those which have appeared in the earlier maps.

The Milky Way is in many places extremely complex, varying much in brightness, with cloudy wisps of light, dark spaces and dark winding lanes. No single-tint representation, such as is used in this atlas, can satisfactorily represent it ; but the outline of Proctor has been followed, for it does at least indicate the general position of the Milky Way and also suggests its complexity.

(e) The Abbreviation List printed in the margins of the 1920 maps was necessarily limited. It has been superseded by the complete List of Abbreviations given on page 55, preceding the charts.

Since the regretted death, early in 1939, of Mr J. Gall Inglis, who was responsible for most of the introductory matter up to page 44, I have been much indebted to his son, Mr R. M. Gall Inglis, for some helpful suggestions, especially with regard to the re-arrangement of the text. A few corrections and additions have been made in this Edition.

ARTHUR P. NORTON

INDEX TO CONTENTS.

Star Catalogues are mostly found only in the annals of observatories or astronomical societies. They are of two types: (a) *Catalogues of precision*, giving the positions with all possible accuracy; (b) *Durchmusterungen*, designed to give star positions to mag. 9 with moderate accuracy only. 1950 is the standard epoch for the present.

A survey of star catalogues from the time of the earliest Greek astronomers till well on in the 19th century, will be found in the *Memoirs R.A.S.*, Vol. 43 : the triennial *Transactions* of the I.A.U. reviews the latest issues. See also Valentiner's *Handwörterbuch der Astronomie*. Some notes on catalogues are given below; various contractions, on p. vii.

In star catalogues, the + and − signs for precession and proper motion are added algebraically, so that in correcting the star's place, *like signs are added, unlike signs subtracted.*

General Catalogues.—The most complete catalogue of precision is that of the Astronomische Gesellschaft (A.G.C. or A.G), which gives positions for all stars to mag. 9, N. of 20° S. Dec.

Boss's Preliminary General Catalogue (P.G.C., 2nd Edition, 1915), gives accurate positions and proper motions of all naked-eye stars : magnitudes are on an old light ratio, see p. 16. A more extended one is in preparation.

The Henry Draper Catalogue (H.D.), gives the positions, magnitudes, and spectral type of 225,000 stars to about magnitude 10 (*H.A.*, vols. 90-99 ; precession and proper motion data are not given). Earlier works are the *Revised Harvard Photometry* (H.R.) 1908, in *H.A.* vol. 50 ; the *H.P.*, 1898 ; Gould's *C.G.A.*, 1886, and *U.A.*, 1879.

Dritter Fundamental Katalog. (F.K.3) of the Berliner Astron. Jarbuch. To be used as basis of international ephemerides. *Schlesinger's Catalogue of Bright Stars* (B.S.) to mag. 6·5, *Pub. Yale University Obs.*, 1930.   [by side. *Backhouse's Cat.*, 1911, of all naked-eye stars, is good and inexpensive ; the magnitudes of various authorities are given side *The N.A.* gives some 500 bright-star positions annually. The *Geschichte des Fixsternhimmels* (G.F.H.), when completed, will contain all meridian observations made before 1900.

Parallaxes. *Schlesinger's Catalogue* is a compilation of all published parallaxes, revised to 1935 (*Pub. Yale University Obs.*). *Boss's P.G.C.*, see above. *Spectroscopic Absolute Magnitudes and Parallaxes, Mt. W. Contr.*, No. 511.

Proper Motions.—*Boss's P.G.C.*, see above. *Pub. Cincinnati Observ.*, vol. 18, gives all proper motions known to exceed 10″ per century. The *Eigenbewegungs Lexikon* (E.B.L., *Hamburg Obs.*), gives references to all published proper motions to 1935.

Radial Velocities.—List of over 1000, *Ap. J.*, vol. 57. *Moore's Radial Velocity Catalogue* of Stars, Nebulæ and Clusters, *Pub. Lick Obs.*, Vol. 18, 1932.

Nebulæ and Clusters.—The standard work is the 'N.G.C.' or *New General Catalogue* (in vol. 49, *Memoirs R.A.S.*), extended by the *Index Catalogue* (I.C.), 1904, 1908; see also Melotte's list, *Mem. R.A.S.*, vol. 60, part v., p. 125. For lists of the Globular Clusters, see *H.A.* vol. 76, and *H.C.O. Bulletin*, 776.

Dark Nebulæ.—Barnard's Photographic Atlas and Catalogue of Dark Nebulæ. (*Ap. J.*, vol. 49, 1919.)

Variable Stars.—See Hagen's *Atlas Stellarum Variabilium* with catalogue (1899-1908) ; various publications of Harvard College Observatory, and the Reports and Annual Handbook of the B.A.A.

Double Stars.—*Burnham's General Catalogue of Double Stars* (B.G.C.), and additional vols. *Aitken's Double Stars* (A.D.S.), within 120° of N. Pole, epochs 1900, 1950 ; all measts. to 1926; practically *B.G.C.* extension ; *Pub. Carnegie Instit., No. 417*, 2 vols. *Innes's Southern Double Star Catalogue* (S.D.S.), south of −19°, about 1927. *Moore's Fourth Catalogue of Spectroscopic binaries*, (*L.O.B.* 483).

Minor Planets.—History and summary of all work done up to ⟨1901⟩ (1928), *Pub. Lick Obs.*, vol. xix, II.

Map of Mercury by M. E. M. Antoniadi, in *L'Astronomie*, Oct. 1935.

Map of Mars, by M. E. M. Antoniadi, in four plates, 8vo., in *L'Astronomie, 1930*, p. 411. A beautiful map, from the same author's *La Planète Mars, 1659-1929* ; 240 pp., 4to., Paris ; a valuable summary. See also Webb's *Celestial Objects*.

Maps of the Moon. See p. 31; also "Who's Who in the Moon," notes on all lunar formations adopted by I.A.U. (*Mem. B.A.A., 1935*).

Wave-lengths.—*Rowland's (Revised): Pub. Carnegie Institute*, No. 396.

Galactic Co-ordinates. Table in *Schlesinger's Catalogue* (B.S., above), and *Lund Annals*, vol. 3, 1932, for 12 h. 40m. + 28°, 1900; also in *M.N.*, vol. 53, p. 74 (Marth, see p. 10). See also Charts 17-18.

Telegraphic Code (I.A.U., Revised 1935). See B.A.A. annual *Handbook*, 1936, for the more important items.

The Year's Progress.—See the Annual Report of the Royal Astronomical Society (Feb.), a valuable summary; it gives the names and numbers of the recognised minor planet discoveries. The Yearbook of the Carnegie Institute gives some useful summaries. *Science Abstracts* (Physical Section) indexes papers in the principal astronomical publications of the world. See also the *Bulletin Astronomique*, and the *Astronomische Jahrbuch*.

For earlier astronomical literature, the *International Catalogue* (discontinued 1917) indexed annually, under the various subjects, the papers in the principal astronomical publications of the world. Houzeau's *Vade Mecum de l'Astronome* (1882) is also a good guide.

Star Counts or Gauges, originated by Sir W. Herschel, are used for ascertaining the distribution of the stars on the star sphere. A number of representative areas are selected ; the stars in each are carefully counted, and their positions, magnitudes, proper and radial motions, spectra, and parallaxes, ascertained, so far as is possible. A Table of the number of stars of each magnitude, per square degree, is given in the B.A.A. Handbook for 1926.

Selected Areas (*Kapteyn's* ; S.A.), a great photographic Star Count of some 250,000 stars (limiting mag. 16, International), had, as planned, 206 representative areas, each 75′ square, or circles 42′ in radius, on or near the circles of N. and S. Dec. 0°, 15°, 30°, 45°, 60°, 75°, 90°; also 46 Milky Way areas: this, however, proved too onerous for rich regions, and some areas were restricted thus—Galactic longitude N. and S., 0°-20°, 40′ × 40′; 20°-40°, 60′ × 60′; 40°-90°, 80′ × 80′. The results are being published by the various co-operating observatories over the world; refer to *Trans. I.A.U.* reports.

Harvard Standard Regions.—Similar to the *N. Polar Sequence* (p. 12 ; *H.A.*, vol. 76, No. 3). A catalogue of 2500 stars, giving magnitudes, spectra, colour indices, &c., for the whole sky ; 48 centres of 30° each ; *H.A.*, vol. 76, No. 4.

Astronomical Societies, Publications, &c.—Contractions commonly used. Standard contractions are now being prepared. first list of General Contractions, and those for Places., see Trans. I.A.U. 1928.

General.

Publication, or Society.		*Publication, or Society.*			
A.A.S.	American Astronomical Society.	H.A.	Harvard Observatory Annals.	*An.*	Annals.
A.A.V.S.O.	American Association of Variable Star	H.B.	Harvard Bulletin.	*App.*	Appendix.
A.E.	American Ephemeris. [Observers.	H.C.	Harvard Circular (Harv. C.).	*Ass.*	Association.
A.G.	Astronomische Gesellschaft	H.C.O.	Harvard College Observatory.	*B., Bull.*	Bulletin.
A.J.	Astronomical Journal.	I.A.U., I.U.A., U.I.A. Internat. Astron. Union.		*Cat.*	Catalogue.
A.N.	Astronomische Nachrichten.	J.	Journal. (prefixed to Society name,as *J.B.A.A.*).	*Cir.*	Circular.
Ap.J.	Astrophysical Journal.	J.O.	Journal des Observateurs.	*Cont.*	Contributions.
A.S.P.	Astronomical Society of the Pacific.	L.O.B.	Lick Observatory Bulletin (Lick B.)	*Edn.*	Edition.
B.	Bulletin (Prefixed).	M.N.	Monthly Notices Royal Astron. Society.	*I.*	International.
B.A.	British Association.	Mt.W., M.W. Mt. Wilson Observatory.		*Ist., Inst.*	Institute.
,,	Bulletin Astronomique.	*Nat.*	Nature.	*M., Mem.*	Memoirs.
B.A.A.	British Astronomical Association.	N.A.	Nautical Almanac.	*Mag.*	Magazine.
B.A.N.	Bulletin of the Ast. Inst. of the Netherlands	*Obs.*	The Observatory.	*O., Obs.*	Observatory.
B.J.	Berliner Jahrbuch.	P.	Publications, Proceedings.(prefixed to Society	*Pr.*	Proceedings.
B.S.A.F.	Bulletin de la Société Astronomique de	P.A.	Popular Astronomy. [name, as, *P.A.S.P.*).	*P.,Pub.*	Publications,
C.O.	Cincinnati Observatory. [France.	P.A.S.P.	Pub'ns of Astronomical Socy. of the Pacific.		or Published.
C.R.	Comptes Rendus (Paris Acad. Sciences).	*Phil. Trans.* Philosophical Transactions of the Royal		*R.*	Review.
C.T.	Connaissance des Temps.	R.A.S.	Royal Astronomical Society. [Socy.	*Rp.*	Report.
D.A.O.	Dominion Astrophysical Observ., Victoria,	R.A.S.C. Royal Astronomical Society of Canada.		*S., Socy.*	Society.
D.O.	Dominion Observatory (Ottawa). [B.C.	S.A.	Scientific American.	*S.*	Smithsonian.
E.B.	Encyclopedia Brittannica.	,,	Selected Areas (*Kapteyn's*), p. vi.	*Tr.*	Transactions.
E.M.	English Mechanic.	U.O.C.	Union Observatory Circulars.	*Vol.*	Volume.
		V.J.S.	Verteljahrsschrift der Astron. Gesellschaft.	*Yb.*	Yearbook.
				Zs	Zeitschrift

Astronomical Catalogues.—Contractions in ordinary use. The letters are often used without points.

Contraction.	*With number added, =Number in :—*
A.C.	Astrographic Catalogue,* to mag. 11 (in progress).
A.D.S.	Aitken's Double Star Catalogue, 1932 (see p. vi).
A.G., A.G.C.	Astronomische Gesellschaft, Catalogues (see p. vi).
Arg.	Argelander. (See B.D. below). [Also = C.G.A.
B.	Birmingham's Catalogue of Red Stars, 1877. (See E-B.).
B.	(In *Nautical Almanac*) Bode's Catalogue, 1801.
B.A.C.	British Association Catalogue, epoch 1850 (*Baily*, 1845).
B.D.	Bonn Durchmusterung (*Argelander*) to mag. 9, 1859-62.* 2° to 23° South Dec., extended by Schönfeld (1886).
β	Burnham's Double Star Catalogues (not his General Cat.,
B.G.C.	Burnham's General Cat. of Double Stars. [B.G.C.)]
Br.	Auwer's reduction of Bradley's Observations.
Bris. or Br.	Sir T. Brisbane's Catalogue of Southern Stars, 1835.
C.D.	Cordoba Durchmusterung, 22° to 62° S. [(*Gould*) 1886,
C.G.A.	Catalogo General Argentino, 32,448 Southern Stars.
C.P.D.	Cape Photographic Durchmusterung, to mag. 9, 19° to 90° South Dec. (*Gill and Kapteyn*), 1896-1903.
C.Z.	Cordoba Zone Cat. of South Stars, Nos. in zones of Dec.*
Δ	Dunlop's Catalogues of Double stars and Nebulæ, 1828.
E-B.	Espin's edition of Birmingham's Cat. of Red Stars, 1888.
E.B.L.	Eigenbewegungs Lexikon (*Hamburg Obs.*) of all known
FK 3	Dritter Fundamental Katalog (p. vi.). [proper motions.
G.	(In Brit. Naut. Almanac) = U.A.
G.F.H.	Geschichte des Fixsternhimmels, see p. vi.
Gr.	Groombridge's Cat. of Circumpolar Stars for 1810, 1838.
H.	Sir W. Herschel's Catalogues of Double Stars,1782-1822.
,,	(In *Nautical Almanac*) Hevelius's Catalogue, 1660.
H'.	(,, ,,) Heis' Catalogus Stellarum, 1872.
Houz.	Houzeau's Uranométrie Générale, 1878.
h.	Sir J. Herschel's Catalogues of (1) Nebulæ ,1833, 1847 ; and (2) of Double Stars.

Contraction.	*With number added, =Number in :—*
H.D.	Henry Draper Cat. 1918-24(vols. 91-99, Harvard Annals),
H.P.	Harvard Photometry (*Pickering*), 1884. (*H.A.* vol. 14).,
H.R. (also R.H.P.).	Revised Harvard Photometry, 1908 (vol. 50.
I.C.	Index Catalogue, extension of N.G.C. 1904, 1908. [*H.A.*).
Jac.	Jacob's Catalogue of Double Stars.
Lac.	Lacaille's Catalogue of Southern Stars, Epoch 1750, published by the British Association, 1847.
Ll.or Lal.	Lalande's Cat., Epoch 1800, pub. by the *B.A.*, 1837.
M.	Messier's Catalogue of 103 Nebulæ & Clusters, pub. 1784. Reprinted, *Obs.*, Aug. 1918; and *P.A.S.P*, Aug. 1917,
N.G.C.	New General Catalogue (of Sir J. Herschel's Nebulæ and Clusters, *Dreyer*), 1888. Vol. 49, Memoirs, R.A.S.
O.A.	Oeltzen's reduction of Argelander's Zone Observations,
P.D.	Potsdam General Cat. (Supplementary vols., P.P.D., &c.)
P.G.C.	Preliminary General Catalogue of 6188 stars (*Boss*), 1910.
ph.	Great International Photographic Star Map.
Pi.	Piazzi's Star Cat., epoch 1800, 1803-14.†
Rus.	Russell's Double Star Measures (Sydney), 1891.
S.	South's Measures of Double Stars, 1826.
Sa.	Santiago Observations, 1876.
S.D.S.	Southern Double Star Catalogue (*Innes*) 1927.
S.M.P.	Southern Meridian Photometry (Harvard), 1895.
St.	Stone's Cape Catalogue for 1880, or Radcliffe Cat.,1890.
W.B.	Weisse's reduction of Bessel's Zones, equinox 1825; Nos. in
W.Z.C.	Washington Zodiacal Cat., 1900, 1920. [hrs. of R.A.
U.A.	Uranometria Argentina (*Gould*), 1879.
U.O.	Uranometria Nova Oxoniensis (*Pritchard*), 1885.
Σ	Wilhelm Struve's Dorpat Cat. of Double Stars, 1837.
ΣI	do. do. Appendix I.
OΣ	Otto Struve's Revised Pulkova Catalogue, 1850.
OΣΣ	Pulkova Catalogue, Part II.

* In this case the zone is stated as well as the number : thus B.D. +13° 2302 means star No. 2302 in the 13° zone, north Dec., in the B.D.
† The numbering commences anew in each hour of R.A.: thus Vʰ 123 denotes star No. 123 in the zone of 5 h. R.A.

Bode's Law.—Taking Mercury as 4, adding 4 to each term of the geometrical series 3, 6, 12, 24, &c., gives the approximate distances of the planets up to Uranus, but not Neptune's: Pluto is near the position Neptune should occupy. No reason is known for this curious relation. Bode remarked that a planet was missing at the distance where the asteroids were discovered later.

Planet ..	Mercury	Venus	Earth	Mars	Asteroids	Jupiter	Saturn	Uranus	Neptune	Pluto	...	...	...
Geometrical Series .	...	3	6	12	24	48	96	192	384	768	...	...	...
Add ...	4	4	4	4	4	4	4	4	4	4	...	...	...
Dist. fr. Sun, Bode	4	7	10	16	28	52	100	196	388	772	...	...	...
,, Actual ...	3·9	7·2	10	15·2	27·4	52	95·4	192	301	395	...	...	...

Albedo of the Planets. Russell's figures are for *Bond's Albedo* (somewhat different from Lambert's original definition on p. 7 : see *Ap. J.*, vol. 43, 1916).

Albedo:—		Mercury	Venus	Earth	Moon	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto		Clouds
(Zöllner, 1865)	...	·13	·50	...	·17	·27	·62	·52	·64	·46	...	...	·65-·72
(Müller, 1897)	...	·14	·76	·20	·13	·12	·62	·72	·60	·52	...	...	Snow
(Russell, 1916)	...	·07	·59	·45	·07	·15	·56	·63	·63	·73	...	...	·70-·78

Saturn's Rings.—Approximate date of Earth passing the ring-plane ; and Saturn's heliocentric longitude. Dates not "0" are minima : the Earth did not quite pass the plane of the ring in 1936, though extremely near doing so.

Date	lat. long.	Date	lat. long.	Date	lat. long.	Date	lat. long.	Date
1889 Dec. 13.	−7°·9 153¼°	1907 Apr. 13.	0° 349°	1920 Nov. 7.	0° 167°	1936 Jun. 28.	(+0°) 346°	1950 Sept. 14
1891 Sept. 22.	0° 170½°	,, Oct. 4.	0° 354°	1921 Feb. 22.	0° 183°	1937 Feb. 21.	0° 354°	... ...
1892 May 31.	+0°·4 179¼°	1908 Jan. 7.	0° 358°	,, Aug. 2.	0° 189°	,, Nov. 28.	−2½° 4°	... ...

Parallaxes:—Sun.   Adopted at Paris Conference, 1911.   8″·80.*

Moon. Equatorial horizontal parallax, at mean distance, 57′ 2″·7.

Asteroids (approximate maximum). *Eros,* 52″. *Amor,* 73″. *1932 H.A.,* 4′. *Adonis,* 8½′.

Stars. The parallaxes of several of these are given in the Tables of the Brightest and Nearest Stars on page 53.

Planetary Colour Indices, &c.—"Sun's Radiation" gives the amount received per unit of area.

	Mercury	Venus	Earth	Moon	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto		
Colour Index (Sun 0·72)	+...	+0·91	...	+1·2	+1·45	+0·96	+1·22	+0·94	+...	0·67	...	...
Sun's Radiation ...	6·6	1·9	1·0	1·0	0·43	0·04	0·01	0·003	0·001	0·0006	...	...
Velocity of escape, km/secs.	3·6	10·2	11·2	2·4	5·0	60	36	21	23	3?	...	...

Stellar Colour Indices.—

Type of Star.	...	...	O	B0	A0	F0	G0	K0	M	M3	Nc	R	S
Colour Index, ...	...	Giants ...	−0·32	0·0	+0·38	+0·86	+1·48	+1·88	...	+5·5	...	...	
do ...	...	Dwarfs ...	−0·32	0·0	+0·38	+0·72	+0·99	+1·76	...	...	...	...	
Heat Index (average), in Magnitudes ...			−0·1	0·0	+0·3	+0·7	+1·2	+2·3	...	...	...	...	
Surface Brightness, ,,		Giants ...	−3·2	−2·3	−1·0	+0·3	+2·3	+4·5	...	...	...	...	
do ,,		Dwarfs ...	−3·2	−2·3	−1·0	0·0	+1·2	+3·8	...	...	...	...	

Novæ.—Many so-called New Stars have been recorded in years previous to those given in the list below. Thus the appearance of a new star about the year 150 B.C. is said to have led Hipparchus to make his catalogue of stars. But generally, the old records are vague and indefinite, and, in some cases, undoubtedly refer not to Novæ but to comets.

Modern Novæ.—Only the brighter Novæ are included in this List.

Year A.D.	Nova:—	Greatest Mag.	Approx. Long.	Galac. Lat.	Position 1900. R.A.	Dec.	Year A.D.	Nova:—	Greatest Mag.	Approx. Long.	Galac. Lat.	Position 1900. R.A.	Dec.
1572.	Cassiopeiæ (B)	>1	88°	+ 2°	0ʰ 22ᵐ	+63° 53′	1910.	Aræ	6·0	302°	− 5°	16ʰ 37ᵐ	−52° 20′
1600.	Cygni No. 1 (P)	3·5	43	+ 0	20 16	+37 52	1912.	Geminorum No.2	3·3	152	+16	6 52	+32 12
1604.	Ophiuchi No. 1	>1	332	+ 5	17 28	−21 27	1913.	Sagittæ ...	7·2	25	− 9	20 5	+17 32
1670.	Vulpeculæ(11)...	3	31	− 0	19 46	+27 11	1917.	Ophiuchi No. 5	6·5	321	+ 8	16 50	−29 33
1848.	Ophiuchi No. 2	5·5	335	+16	16 57	−12 48	1918.	Aquilæ No. 3	−0·7	1	− 1	18 46	+ 0 32
1860.	Scorpii (T) ...	7	321	+18	16 14	−22 31	1919.	Ophiuchi ...	7·5	7	+12	18 11	+11 35
1866.	Coronæ (T) ...	2	10	+47	15 57	+26 4	1919.	Lyræ ...	6·5	27	+11	18 51	+29 9
1876.	Cygni No. 2 (Q)	3	58	− 8	21 40	+42 34	1920.	Cygni No. 3 ...	1·8	55	+12	19 57	+53 29
1885.	Andromedæ (S)	7	89	−21	0 40	+40 59	1925.	Pictoris (RR) ...	1·1	240	−25	6 35	−62 36
1887.	Persei No. 1 (V)	9·2	100	− 4	1 58	+56 29	1934.	Herculis ...	1·3	40	+25	18 7	+45 51
1891.	Aurigæ (T) ...	4·5	145	− 0	5 29	+30 25	1936.	Lacertæ ...	2·0	70	− 1	22 14	+55 23
1893.	Normæ (R) ...	7	295	+ 4	15 26	−50 25	1936.	Aquilæ ...	7·0	5	− 6	19 15	+ 1 38
1895.	Carinæ (RS) ...	8	259	− 1	11 6	−61 40	1936.	Sagittarii ...	4·5?	325	− 8	18 5	−34 21
1895.	Centauri (Z) ...	7	283	+29	13 37	−31 23	1936.	Aquilæ ...	5·0	11	− 6	19 24	+ 7 30
1898.	Sagittarii No. 1	4·7	350	−10	18 59	−13 14	1942.	Puppis ...	0·4	221	+ 0	8 10	−35 13
1899.	Sagittarii No. 3	8·5	335	− 6	18 17	−25 13	1946.	Coronæ (T) ...	3·1	...	(See	yr. 1866	above)
1899.	Aquilæ No. 1 ...	7	4	− 8	19 18	− 0 14	1950.	Lacertæ ...	6·0	73	− 5	22 48	+53 2
1901.	Persei No. 2 ...	0·0	119	− 9	3 26	+43 24							
1903.	Geminorum No.1	5·1	153	+13	6 41	+30 0	...	...	...	...	...	...	...
1905.	Aquilæ No. 2 ...	9	358	− 6	19 0	− 4 31							
1910.	Sagittarii No. 2	7·5	331	− 3	17 57	−27 33							
1910.	Lacertæ No. 1	5·0	71	− 5	22 33	+52 22	...	...	...	...	...	...	...

* From observations of Eros around the opposition of 1931, the value is 8″·790 ± 0″·001 (see B.A.A. Handbook for 1942).

Nomenclature of Minor Planets, Variable Stars, Novæ, &c.—Systems that answered well in the early stages of discovery inevitably tend to become inadequate or unwieldy as discoveries increase, and from time to time they have to be revised. The following modifications have been made in the original systems.

Minor Planets. Each new discovery, before the number and name is given (p. 35), is temporarily assigned distinctive Roman letters, as not infrequently, a supposed new asteroid proves to be identical with one already known. Originally a single letter sufficed, and the year; but in 1893, the double form AA to AZ, BA to BZ, &c., was introduced (I being omitted), this new series being continued right on until ZZ was reached, instead of beginning the alphabet afresh each year. A second alphabet was begun in 1907, with the year (1907 AA, &c.), and a third in 1916—terminated with UA., Dec. 31, 1924, when a new system was started to enable belated discoveries to be inserted in approximately their proper place.

Under the present system of temporary nomenclature, the double alphabet begins afresh each year; the discoveries of Jan. 1-15 are AA, AB, AC, &c.; of Jan. 16-31, BA, BB, BC, &c.; of Feb. 1-15, CA, CB, &c., the year being added in each case; if more discoveries than 25 in half a month, AA_1, AB_1, &c. Minor planets are in the care of the Rechen-Institut of Berlin, which attends to the numbering, &c. When unnumbered, the orbit is not sufficiently certain, as 1932 HA, but a name may be given, as it is more convenient for reference. (Annual summary in *M.N.*, February).

Jan. A,B; Feb. C,D; Mar. E,F; Apr. G,H; May J,K; June L,M; July N,O; Aug. P,Q; Sept. R,S; Oct. T,U; Nov. V,W; Dec. X, Y.

Variable Stars. Argelander designated those not otherwise lettered or numbered, in any constellation, by the Roman capital letters, R, S, T, U, V, W, X, Y, Z. After Z, the double form RR to RZ, SS to SZ, TT to TZ, and so on to ZZ, was used, which provided for 54 variable stars in any constellation. As that number proved insufficient, AA to AZ, BB to BZ, and so on, was employed, J being omitted. The simplest system, which denotes the variables of each constellation by the letter V, followed by a number—thus V1 = R; V2 = S; V54 = ZZ, &c., is to be used from V335, when QZ is reached. Letters are assigned when the variability is confirmed; provisionally, Novæ and ordinary variables are now designated by a number, year, and constellation, Nova Aquilæ 1918 being 7.1918 Aquilæ, in the 'variable' discoveries of 1918.

Novae. The older Novæ are designated by the constellation and year in which they appeared, thus, *Nova* Scorpii, 134 B.C.: some having also a 'popular' name, as *Kepler's Star*, *Tycho's Star*, &c. Modern Novæ were similarly designated till 1925: if more than one appeared in a constellation, they were numbered successively *Nova* I., *Nova* II., and so on, of that constellation, in order of discovery, disregarding the Novæ before 1572. As many Novæ were only discovered years after their appearance, when comparing star photographs of the same region taken at different times, this sometimes resulted in the numbers being out of order as regards date of *appearance*: the nomenclature was therefore altered to constellation and year, with the date in tenths of a year, if more than one in a year.

Primary and Secondary Stars.—The brightest star is A, the companion or companions B, C, &c., as *Sirius A* and *B*.

Comets.—Entirely new comets are usually named after the discoverer, adding the year, as Donati's comet, 1858.

Comet a, Comet b, &c., denotes the first, second, ... comet *discovered* that year, whether new or already known.
Comet I, Comet II, &c.,   „   „   „   „   *arriving at perihelion* that year,   ditto

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Some Terms occurring in Astronomical Papers. (Fuller details in Young's Revised Astronomy, *by Russell, &c.*).

Errors of Observation.—These are of two kinds: *Systematic Errors* and *Accidental Errors* (see page 7, *Equation*). The former are detected by observations repeated with different instruments, &c., or by comparison with results obtained by other methods; the latter errors are erratic, but can be allowed for by analysis of the small discrepancies between the individual observations of a series, or between observed and calculated values—which discrepancies or differences are known as *Residuals*.

The Probable Error (P.E.), of a series of observations is a value derived mathematically from these residuals; it affords an index to the reliability of the figures given, and is prefixed by the sign ±, which means that it is an even chance whether, by the amount of the probable error, the value given is greater, or less. The smaller the probable error, the greater the reliability.

Method of Least Squares.—A method used to ascertain the most probable mean value derivable from a number of different observations. It is based on the principle that the 'weights' (degree of accuracy) of observations, with different probable errors, are inversely proportional to the squares of their probable errors.

Interpolation; Extrapolation.—*Interpolation* is the process of finding values for dates, hours, quantities, &c., intermediate to those given in a Table. For ordinary purposes, the proportional amount of the difference between the figures for the two nearest dates, quantities, &c., usually suffices, it being assumed, for simplicity, that the change in the interval is uniform; a more accurate result, useful when maximum or minimum occurs between the dates, is obtained by plotting on squared paper several successive dates, or figures, on each side of the one not given, and drawing a curve through these points.

Extrapolation, a similar process, extends a series of figures beyond the limit of the last figure actually known; there being only one limiting figure, however, it is less simple than interpolation.

Contracted Notation employs the factor '10,' with small index figures, to express large numbers in a small space. The index figures may be taken as indicating the number of ciphers to be added after the 1. A *minus* before the index figures indicates a fractional number, viz., 1 divided by that number; thus 10^{-6} = 1/1,000,000th or ·000001, from which it appears that *minus* index figures show the position, *after* the decimal point, of the first significant figure of the decimal fraction, the number of ciphers before the 1 being *one less* than the index number. The following are examples with decimal factors:—

$1·23 \times 10^6 = 1·23 \times 1,000,000$ or $123 \times 10^4 = 1,230,000$. $1·23 \times 10^{-6} = 1·23 \times ·000001$ or $123 \times 10^{-8} = 123 \times ·00000001 = ·00000123$.

Note to make the index of the 10 such that the figure before the decimal in the other factor is *1 to 9 only*; thus $1·23 \times 10^6$ is correct, not the 123×10^4 illustrating the working: the index of 10 (both + and −) is then the 'characteristic' of the logarithm of the No.

10^1 = 10 ... ... = 1 with 1 cipher after it	10^{-1} = 0·1 ... ... = 1 in the 1st place after decimal point.
10^3 = 1000 ... ... 1 „ 3 ciphers „	10^{-2} = 0·01 (1/100th) „ „ 2nd „ „ „
10^6 = 1 million ... ... 1 „ 6 „ „	10^{-6} = 0·000001 (1/millionth) „ 6th „ „ „
10^7 = 10 millions ... ... 1 „ 7 „ „	10^{-7} = 0·0000001 (1/10-millionth) „ 7th „ „ „
10^9 = 1 billion (U.S.A., &c.) 1 „ 9 „ „	10^{-9} = 1/billionth (U.S.A.) „ 9th „ „ „
10^{12} = 1 billion (British) ... 1 „ 12 „ „	10^{-12} = „ (British) „ 12th „ „ „

B

Magnitudes and Relative Brightness of the Sun, Planets, and Principal Stars, (1st magnitude star taken as 1·00).

Name of Star, &c.	H.R. Mag.	Brightness	Name of Star	H.R. Mag.	Relative Brightness	Name of Star	H.R. Mag.	Relative Brightness	Name of Star	H.R. Mag.	Relative Brightness
Sun ...	−26·6	{ 109,600 millions	Achernar ...	0·60	1·45	ε Canis Major.	1·63	0·56	δ Canis Major.	1·98	0·41
Moon (Full)	−12·2	190,550	β Centauri ...	0·86	1·14	ε Ursæ Major.	1·68	0·53	β Canis Major.	1·99	0·40
Venus (max.)	−4·28	129·4	Altair ...	0·89	1·11	γ Orionis ...	1·70	0·52	Magnitude	2·00	0·40
Jupiter* ...	−2·25	19·95	Betelgeuse ...	0·92	1·08	a²Centauri ...	1·70	0·52	Polaris ...	2·12	0·36
Mars* ...	−2·25	19·95	Magnitude	1·00	1·00	λ Scorpii ...	1·71	0·52	Magnitude	2·50	0·25
Mercury (max)	−1·8	13·18	Aldebaran ...	1·06	0·95	ε Carinæ ...	1·74	0·51	,, ...	3·00	0·16
Sirius ...	−1·58	10·77	Spica ...	1·21	0·82	ε Orionis ...	1·75	0·50	,, ...	3·50	0·10
Saturn* ... { −0·18 / +0·89		8·00 / 1·11	Pollux ...	1·21	0·82	β Tauri ...	1·78	0·49	,, ...	4·00	0.06
Canopus ...	−0·86	5·55	Antares ...	1·22	0·82	β Carinæ ...	1·80	0·48	,, ...	4·50	0·04
Magnitude	0·00	2·51	Fomalhaut ...	1·29	0 77	a Triang. Aust.	1·88	0·44	,, ...	5·00	0·03
Vega ...	0·14	2·21	Arided ...	1·33	0·74	a Persei ...	1·90	0·44	,, ...	5·50	0·02
Capella ...	0·21	2 07	Regulus ...	1·34	0·73	η Ursæ Major.	1·91	0·43	,, ...	6·00	0·01
Arcturus ...	0·24	2·01	β Crucis ...	1·50	0·63	ζ Orionis ...	1·91	0·43	Uranus* ...	5·8	0·01
a¹ Centauri	0·33	1·85	a¹ Crucis ...	1·58	0·59	γ Geminorum	1·93	0·42	Magnitude	6·50	0·006
Rigel ...	0·34	1·84	Castor ...	1·58	0·59	ε Sagittarii ...	1·95	0·42	Neptune* ...	7·7	0·003
Procyon ...	0·48	1·61	γ Crucis ...	1·58	0·60	a Ursæ Major.	1·95	0·42	Pluto*	(14·5)	·000002

Ratio of Brightness, fainter or brighter, for a difference in magnitude ("Diff.") of :—

Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio
0·1	1·10	0·5	1·58	0·9	2·29	1·3	3·31	1·75	5·01	3·0	15·85	5·5	158·49	8·0	1584·9	10·5	15,849	13·0	158,490
0·2	1·20	0·6	1·74	1·0	2·51	1·4	3·63	1·8	5·25	3·5	25·12	6·0	251·19	8·5	2511·9	11·0	25,119	13·5	251,190
0·25	1·26	0·7	1·91	1·1	2·75	1·5	3·98	1·9	5·75	4·0	39·81	6·5	398·11	9·0	3981·1	11·5	39,811	14·0	398,110
0·3	1·32	0·75	2·00	1·2	3·02	1·6	4·37	2·0	6·31	4·5	63·10	7·0	630·96	9·5	6309·6	12·0	63,096	14·5	630,960
0·4	1·45	0·8	2·09	1·25	3·16	1·7	4·79	2·5	10·00	5·0	100·00	7·5	1000·00	10·0	10,000·0	12·5	100,000	15·0	1,000,000

Distance and Magnitude :—

Increase of distance ("Dist.") for a difference ("Diff.") of 1 to 20 magnitudes. Thus a Mag. 5 star placed 100 times further away would be 10 magnitudes fainter, or Mag. 15. (Mag.-diff. × 0·2 = logarithm of distance-increase).

Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.
½	1·26	2	2·51	4	6·31	6	15·85	8	39·81	10	100·0	12	251·2	14	631·0	16	1585	18	3981	19	6310
1	1·59	3	3·98	5	10·00	7	25·12	9	63·10	11	158·5	13	398·1	15	1000	17	2512	18½	5012	19½	7943
																				20	10000

Mean Refraction (Bessel).

For 50° F. (10° C.), and barometer 29·6 ins. (752 mm). Other Temperatures, add 1% per 5° F. (2·8° C.) if lower, deduct if higher : Pressures, add 3½% per inch (25·4 mm.) if higher, deduct if lower ; = abt. 1% ♃ ¼ inch, or ♃ 6 mm.

Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction	Alt.	Refraction
0°	34' 54"	¼°	26' 35"	3°	14' 15"	6°	8' 23"	9°	5' 49"	12°	4' 25"	15°	3' 32"	25°	2' 3"	40°	1' 9"	65°	0' 27"
¼	31 50	1	24 25	4	11 39	7	7 20	10	5 16	13	4 5	16	3 19	30	1 40	45	0 58	80	0 10
½	29 3	2	18 9	5	9 47	8	6 30	11	4 49	14	3 47	20	2 37	35	1 22	50	0 48	90	0 0

Light-Years equivalent to Parsecs.

Multiples by 10, 100, shift point one, two, places to rt. P., parsecs ; L/y., light-yrs.

P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.
1	3·259	6	19·554	11	35·85	16	52·14	21	68·44	26	84·73	31	101·03	36	117·32	41	133·62	46	149·91	60	195·54
2	6·518	7	22·813	12	39·11	17	55·40	22	71·70	27	87·99	32	104·29	37	120·58	42	136·88	47	153·17	70	228·13
3	9·777	8	26·072	13	42·37	18	58·66	23	74·96	28	91·25	33	107·55	38	123·84	43	140·14	48	156·43	80	260·72
4	13·036	9	29·331	14	45·63	19	61·92	24	78·22	29	94·51	34	110·81	39	127·10	44	143·40	49	159·69	90	293·31
5	16·295	10	32·590	15	48·89	20	65·18	25	81·48	30	97·77	35	114·07	40	130·36	45	146·66	50	162·95	100	325·90

Parsecs and Light-years equivalent to any parallax (π).

·0001, ·0002, &c., move parsec or light-yr. decimal one place to rt.

π	Parsecs	Light-yrs.	π	Parsecs	Light-yrs.	π	Parsecs	Light-y.	π	Parsecs	Light-y.	π	Parsecs	Light-y.	π	Parsecs	Light-y.
·001"	1000	3259·0	·021"	47·62	155·19	·041"	24·39	79·49	·061"	16·39	53·43	·081"	12·35	40·24	·12	8·33	27·16
·002	500·0	1629·5	·022	45·45	148·14	·042	23·81	77·61	·062	16·13	52·57	·082	12·20	39·75	·14	7·14	23·28
·003	333·3	1086·3	·023	43·48	141·69	·043	23·26	75·79	·063	15·87	51·74	·083	12·05	39·26	·15	6·67	21·73
·004	250·0	814·74	·024	41·67	135·79	·044	22·73	74·06	·064	15·63	50·92	·084	11·90	38·80	·16	6·25	20·37
·005"	200·0	651·79	·025"	40·00	130·36	·045"	22·22	72·43	·065"	15·38	50·14	·085"	11·76	38·34	·18	5·56	18·11
·006	166·7	543·16	·026	38·46	125·35	·046	21·74	70·84	·066	15·15	49·39	·086	11·63	37·90	·20	5·00	16·30
·007	142·9	465·56	·027	37·04	120·70	·047	21·28	69·34	·067	14·93	48·64	·087	11·49	37·46	·22	4·55	14·81
·008	125·0	407·37	·028	35·71	116·39	·048	20·83	67·91	·068	14·71	47·93	·088	11·36	37·03	·24	4·17	13·58
·009	111·1	362·11	·029	34·48	112·38	·049	20·41	66·51	·069	14·49	47·24	·089	11·24	36·62	·25	4·00	13·04
·010"	100·0	325·90	·030"	33·33	108·63	·050"	20·00	65·18	·070"	14·29	46·56	·090"	11·11	36·21	·26"	3·85	12·54
·011	90·91	296·27	·031	32·26	105·13	·051	19·61	63·90	·071	14·08	45·90	·091	10·99	35·82	·28	3·57	11·64
·012	83·33	271·58	·032	31·25	101·84	·052	19·23	62·68	·072	13·89	45·27	·092	10·87	35·42	·30	3·33	10·86
·013	76·92	250·69	·033	30·30	98·76	·053	18·87	61·49	·073	13·70	44·65	·093	10·75	35·04	·35	2·86	9·31
·014	71·43	232·79	·034	29·41	95·85	·054	18·52	60·35	·074	13·51	44·04	·094	10·64	34·67	·40	2·50	8·15
·015"	66·67	217·27	·035"	28·57	93·11	·055"	18·18	59·25	·075"	13·33	43·45	·095"	10·53	34·31	·45"	2·22	7·24
·016	62·50	203·69	·036	27·78	90·53	·056	17·86	58·20	·076	13·16	42·88	·096	10·42	33·95	·50	2·00	6·52
·017	58·82	191·70	·037	27·03	88·08	·057	17·54	57·17	·077	12·99	42·33	·097	10·31	33·60	·55	1·82	5·92
·018	55·56	181·05	·038	26·32	85·76	·058	17·24	56·20	·078	12·82	41·78	·098	10·20	33·26	·60	1·67	5·43
·019	52·63	171·53	·039	25·64	83·56	·059	16·95	55·23	·079	12·66	41·26	·099	10·10	32·92	·65	1·54	5·01
·020"	50·00	162·95	·040"	25·00	81·47	·060"	16·62	54·32	·080"	12·50	40·74	·100"	10·00	32·59	·70	1·43	4·66
															·75"	1·33	4·35

*Mean opposition magnitudes : star magnitudes only are from the H.R.

Parsecs or Light-years equivalent to Km/seconds Velocities, at 500 km/seconds (310·69 mile/secs.) per megaparsec; or 153·42 km./secs. (95·33 mile/secs.) per megalight-year. For per km/ or mile/ day, or year, multiply by 86,400, or 31½ millions.

km/ secs.	Millions of: Pcs. Lly.	km/ secs.	Millions of: Pcs. Lly.	km/ secs.	Millions of:— Pcs. Lly.	km/ sec.	Millions of— Pcs. Lly.	km/ secs.	Millions of:— Pcs. Lly.	km/ secs.	Millions of:— Pcs. Lly.	km/ secs.	Millions of:— Parsecs Light-yrs
100	0·2 0·7	1500	3·0 9·8	4500	9·0 29·3	9000	18·0 58·7	15,000	30·0 97·8	21,000	42·0 136·9	35,000	70·0 228·1
200	0·4 1·3	2000	4·0 13·0	5000	10·0 32·6	10,000	20·0 65·2	16,000	32·0 104·3	22,000	44·0 143·4	40,000	80·0 260·7
300	0·6 2·0	2500	5·0 16·3	5500	11·0 35·8	11,000	22·0 71·7	17,000	34·0 110·8	23,000	46·0 149·9	45,000	90·0 293·3
400	0·8 2·6	3000	6·0 19·6	6000	12·0 39·1	12,000	24·0 78·2	18,000	36·0 117·3	24,000	48·0 156·4	50,000	100·0 325·9
500	1·0 3·3	3500	7·0 22·8	7000	14·0 45·6	13,000	26·0 84·7	19,000	38·0 123·8	25,000	50·0 163·0	55,000	110·0 358·5
1000	2·0 6·5	4000	8·0 26·1	8000	16·0 52·1	14,000	28·0 91·3	20,000	40·0 130·4	30,000	60·0 195·5	60,000	120·0 391·1

Kilometres converted into Miles:—Multiples by 10, 100, 1000, shift decimal point one, two, three places to the right.

km. =miles	km. =miles	km. =miles	km. =miles	km. =miles	km. =miles	km. =miles	km. =miles	km. =miles	km. =miles	km. =miles
1 0·621	6 3·728	11 6·835	16 9·942	21 13·049	26 16·156	31 19·263	36 22·369	41 25·476	46 28·583	60 37·282
2 1·243	7 4·350	12 7·456	17 10·563	22 13·670	27 16·777	32 19·884	37 22·991	42 26·098	47 29·204	70 43·496
3 1·864	8 4·971	13 8·078	18 11·185	23 14·292	28 17·398	33 20·505	38 23·612	43 26·719	48 29·826	80 49·710
4 2·485	9 5·592	14 8·699	19 11·806	24 14·913	29 18·020	34 21·127	39 24·233	44 27·340	49 30·447	90 55·923
5 3·107	10 6·214	15 9·321	20 12·427	25 15·534	30 18·641	35 21·748	40 24·855	45 27·962	50 31·069	100 62·137

Centigrade Degrees converted into Degrees Fahr. (nearest 100, after 1000). For any temperature (under 0°, use *lower* + or—:

$°F. = °C. \times 9 \div 5 \pm 32$; $°C = (°F. \mp 32) \times 5 \div 9$. *For the °K equivalent:*—If above 0° C. *add*, if below subtract from, 273° C. 10C.°=18 F.°

°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.	°C. =°F.
-273 -460	-80 -112	10° 50	110° 230	210° 410	310° 590	410° 770	750° 1382	5500° 9900	11000° 19800	21000° 37800
250 418	70 94	20 68	120 248	220 428	320 608	420 788	1000 1832	6000 10800	12000 21600	22000 39600
200 328	60 76	30 86	130 266	230 446	330 626	430 806	1500 2700	6500 11700	13000 23400	23000 41400
150 238	50 58	40 104	150 284	240 464	340 644	440 824	2000 3600	7000 12600	14000 25200	24000 43200
140 220	40 40	50 122	150 302	250 482	350 662	450 842	2500 4500	7500 13500	15000 27000	25000 45000
130 202	30 22	60 140	160 320	260 500	360 680	460 860	3000 5400	8000 14400	16000 28800	26000 46800
120 184	20 -4	70 158	170 338	270 518	370 698	470 878	3500 6300	8500 15300	17000 30600	28000 50400
110 166	-10 +14	80 176	180 356	280 536	380 716	480 896	4000 7200	9000 16200	18000 32400	30000 54000
100 148	0 32	90 194	190 374	290 554	390 734	490 914	4500 8100	9500 17100	19000 34200	35000 63000
-90 -130	+5 +41	100 212	200 392	300 572	400 752	500 932	5000 9000	10000 18000	20000 36000	40000 72000

'K' Degrees converted into Centigrade and Fahrenheit Degrees (to nearest 100°, after 1000°). 100 K.°=100 C.°=180 F.°

°K. =°C. =°F.	°K. =°C. =°F.	°K. =°C. =°F.	°K. =°C. =°F.	°K. =°C. =°F.	°K. =°C. =°F.
0 -273 -460	500 227 441	4000 3700 6700	7500 7200 13,000	14,000 13,700 24,700	25,000 24,700 44,500
100 -173 -280	1000 727 1341	4500 4200 7600	8000 7700 13,900	15,000 14,700 26,500	30,000 29,700 53,500
200 -73 -99	1500 1200 2200	5000 4700 8500	9000 8700 15,700	16,000 15,700 28,300	35,000 34,700 62,500
255 -18 0	2000 1700 3100	5500 5200 9400	10,000 9700 17,500	17,000 16,700 30,100	40,000 39,700 71,500
273 0 +32	2500 2200 4000	6000 5700 10,300	11,000 10,700 19,300	18,000 17,700 31,900	45,000 44,700 80,500
300 +27 +81	3000 2700 4900	6500 6200 11,200	12,000 11,700 21,100	19,000 18,700 33,700	50,000 49,700 89,500
400 +127 +261	3500 3200 5800	7000 6700 12,100	13,000 12,700 22,900	20,000 19,700 35,500	60,000 59,700 107,500

The Greek Alphabet. The small letters are on the left, the capitals on the right.

Letter Name	Letter Name	Letter Name	Letter Name	Letter Name	Letter Name
α Alpha ...A	ε Epsilon ...E	ι Iota ...I	ν Nu ...N	ρ Rho ...P	φ Phi ...Φ
β Beta ...B	ζ Zeta ...Z	κ Kappa ...K	ξ Xi ...Ξ	σ Sigma ...Σ	χ Chi ...X
γ Gamma ...Γ	η Eta ...H	λ Lambda ...Λ	ο Omicron ...O	τ Tau ...T	ψ Psi ...Ψ
δ Delta ...Δ	θ Theta ...Θ	μ Mu ...M	π Pi ...Π	υ Upsilon ...Υ	ω Omega ...Ω

Degrees equivalent to Right Ascension Hours and Minutes:— Decimals of a Degree,

No. of Seconds of Arc: in 360°, 1,296,000″; in 1°, 3600″. No. of Seconds of Time: in 1 day, 86,400 sec.; in 1 hour, 3600s.

Velocities of Gases in Km./sec.

H, hydrogen; He, helium; H_2O, water; N, nitrogen; O, oxygen; CO_2, carbonic acid.

	-200°C.	-150°	-100°	-50°	0°C.	+50°	100°	200°	300°	400°		-200°	-150°	-100°	-50°	0°C.	+50°	+100°	200°	300°	400°
$H.$	0·95	1·33	1·46	1·66	1·84	2·00	2·15	2·42	2·67	2·89	$N.$	0·25	0·33	0·39	0·44	0·49	0·53	0·57	0·64	0·71	0·77
$He.$	0·68	0·88	1·04	1·18	1·31	1·42	1·53	1·72	1·90	2·06	$O.$	0·24	0·31	0·37	0·42	0·46	0·50	0·54	0·61	0·67	0·72
H_2O	0·32	0·42	0·49	0·56	0·62	0·67	0·72	0·82	0·90	0·97	CO_2	0·20	0·26	0·31	0·35	0·39	0·42	0·46	0·51	0·57	0·61

Ionisation Potentials.—The second value is the voltage required to remove a second electron; it differs widely. Potassium, volts, 4·3, 22; Sodium, 5·1, 30; Lithium, 5·4, 68; Calcium, 6·1, 12; Titanium, 6·8, 14; Magnesium, 7·6, 15; Iron, 8·2, 13; Silicon, 8·2, 16; Sulphur, 10·3, ...; Carbon, 11·3, 24; Hydrogen, 13·5; Oxygen, 13·6, 35; Nitrogen, 14·2, 30; Helium, 24·4, 54 (see p. 24).

Sunset and Sunrise.—The time varies slightly from year to year, but the Sunset Table opposite will give the Apparent or True (Sundial) time of both Sunset or Sunrise within a few minutes, in both Northern and Southern latitudes.

To find the Mean Time equivalent, add or subtract the Equation of Time *(E)* given in small figures. A further correction is required for longitude, of 4 minutes for each degree W. or E. of the Standard meridian—added if W., subtracted if E.

Sunrise.—Subtract the time of Sunset from 12 hrs. 0 min., and adjust for Equation of Time, and longitude, as for Sunset. Thus sunrise on May 25, lat. 45°N., long. 4° W. of Std. meridian, is at 4·38 (12h. – 7h. 35m., – 3m. Equation, +16m. for longitude).

Earliest and Latest Sunrise and Sunset, in different N. Latitudes. There are two 'earliests' and 'latests' in low latitudes.

Latitude	0°	0°	10°	10°	20°	30°	35°	40°	45°	50°	55°	60°
Rising. Earliest:— a.m.	Nov. 4 5.40	May 16 5.53	May 30 5.37	Oct. 11 5.48	June 7 5.20	June 11 4.58	June 14 4.45	June 15 4.30	June 17 4.12	June 18 3.50	June 19 3.20	June 19 2.35
„ Latest:— a.m.	Feb. 12 6.11	July 28 6.03	Aug .24 5.51	Jan. 27 6.23	Jan. 18 6.38	Jan. 11 6.57	Jan. 8 7.09	Jan. 6 7.22	Jan. 3 7.39	Jan. 1 7.59	Dec. 29 8.26	Dec. 28 9.04
Setting. Earliest— p.m.	Nov. 2 5.47	May 14 6.0	Nov. 17 5.35	Apr. 10 6.10	Nov. 26 5.19	Dec. 3 5.0	Dec. 6 4.48	Dec. 8 4.35	Dec. 11 4.18	Dec. 13 3.58	Dec. 15 3.32	Dec. 17 2.53
„ Latest:— p.m.	Feb. 10 6.18	July 25 6.10	July 12 6.25	Mar. 17 6.11	July 5 6.43	July 2 7.5	June 30 7.18	June 28 7.33	June 27 7.51	June 26 8.13	June 25 8.43	June 24 9·28

Sun's Longitude, Right Ascension, and Declension, at 0h. Intermediate dates: for R.A. add 4 minutes ℣ day.

Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.
Jan. 1	280°	...	−23°	Mar. 5	344°	23h	−6°	May 22	60°	...	+20°	Aug. 2	130°	...	+18°	Oct. 13	200°	...	−7°
„ 5	284	19h	23	„ 11	350	...	−4	„ 23	61	4h	20	„ 5	132	9h	17	„ 24	210	...	11
„ 11	290	...	22	„ 21	0	24h	0	June 1	70	...	22	„ 13	140	...	15	„ 29	215	14h	13
„ 18	297	20h	21	„ 31	10	...	+4	„ 7	76	5h	23	„ 21	147	10h	12	Nov. 3	220	...	15
„ 20	300	...	20	Apr. 6	16	1h	6	„ 11	80	...	23	„ 24	150	...	11	„ 10	227	15h	17
„ 30	310	...	18	„ 10	20	...	8	„ 22	90	6h	23½	Sept. 3	160	...	8	„ 13	230	...	18
Feb. 2	312	21h	17	„ 20	30	...	11	July 2	100	...	23	„ 7	163	11h	6	„ 23	240	...	20
„ 9	320	...	15	„ 23	32	2h	12	„ 6	103	7h	23	„ 13	170	...	+4	„ 25	242	16h	21
„ 17	327	22h	12	May 1	40	...	15	„ 13	110	...	22	„ 24	180	12h	0	Dec. 3	250	...	22
„ 19	330	...	12	„ 8	47	3h	17	„ 21	118	8h	21	Oct. 3	190	...	−4	„ 8	255	17h	23
Mar. 1	340	...	−8°	May 11	50	...	+18°	July 23	120	...	+20°	Oct. 10	196	13h	−6°	„ 12	260	...	−23
																Dec.22	270	18h	23½

Equation of Time.—Mean Time ± the minutes in the Table = True or 'sundial' time. Clock before Sun − ; after, +.

Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.
Jan. 1	−3 m.	Jan. 29	−13 m.	Mar.20	−8 m.	Apr.25	+2 m.	Jun.24	−2 m.	Aug.22	−3 m.	Sep. 22	+7 m.	Nov. 4	+16½ m.	Dec.11	+7 m.
„ 3	4	Feb. 4	14	„ 23	7	May 2	3	„ 29	3	„ 26	2	„ 25	8	„ 11	16 m.	„ 13	6
„ 5	5	„ 12	14½	„ 26	6	„ 7	3½	July 4	4	„ 29	−1	„ 28	9	„ 18	15	„ 16	5
„ 7	6	„ 20	14	„ 29	5	„ 15	3¾	„ 10	5	Sep. 2	0	Oct. 1	10	„ 22	14	„ 18	4
Jan. 9	7	„ 24	13½	Apr. 2	4	„ 23	3½	„ 14	5½	„ 5	+1	„ 4	11	„ 26	13	Dec.20	3
„ 12	8	„ 27	13	„ 5	3	„ 28	3	„ 19	6	„ 8	2	„ 7	12	„ 29	12	„ 22	2
„ 15	9	Mar. 4	12	„ 8	2	Jun. 4	2	„ 27	6⅓	„ 11	3	„ 11	13	Dec. 1	11	„ 24	+1
„ 18	10	„ 8	11	„ 12	−1	„ 10	+1	Aug. 5	6	„ 14	4	„ 15	14	„ 4	10	„ 26	0
„ 21	11	„ 12	10	„ 16	0	„ 15	0	„ 13	5	„ 17	5	„ 20	15	„ 7	9	„ 28	−1
Jan. 24	−12	Mar.16	−9	Apr.20	+1 m.	Jun.19	−1 m.	Aug.18	−4 m.	Sep. 19	+6 m.	Oct. 27	+16	Dec. 9	+8	Dec.30	−2 m.

Angular Distances on the Star Sphere.—The following approximations are convenient for rough estimates; others can easily be made up from the star charts : the degrees are those of a 'great circle,' as of Declination, or those on the Celestial equator.

½° = the angular diameter of the Moon (approx.). | 2½° = α to β Aquilæ ; or α to δ Reticuli ... (approx.).

1¼° = δ to ε Orionis : or β to λ Crucis „ | 4° = α to β Canis Minoris ; or α to β Crucis „

2° = α to γ Aquilæ ; or α to σ Scorpii. „ | 5° = α to β Ursæ Majoris ; or α to β Centauri „

The Star Sphere contains 41,253 square degrees.

Approximate Galactic Longitude and Latitude of certain Stars:—

Long.	Lat.	Star	Long.	Lat.	Star	Long.	Lat.	Star
3°	+21°	α Ophiuchi	121°	+47°	υ Ursæ Maj.	230°	−7°	γ Velorum
9°	+52°	α Coronæ	130°	+6°	α Aurigæ (Capella)	240°	+61°	β Virginis
16°	−10°	α Aquilæ (Altair)	132°	+64°	ψ Ursæ Maj.	250°	−13°	α Volantis
20°	+39°	ζ Herculis	135°	+12°	β Aurigæ	256°	−59°	α Eridani (Achernar)
31°	+12°	γ Lyræ	149°	−19°	α Tauri (Aldebaran)	268°	−1°	α Crucis
35°	+18°	α Lyræ (Vega)	155°	+24°	α Geminorum (Castor)	279°	+1°	β Centauri
46°	+1°	γ Cygni	160°	+25°	β Geminorum (Pollux)	284°	−1°	α Centauri
52°	+1°	α Cygni (Deneb)	165°	−15°	γ Orionis (Bellatrix)	285°	+50°	α Virginis (Spica)
59°	+40°	η Draconis	167°	−7°	α Orionis (Betelgeuse)	289°	−16°	α Trianguli Aus.
65°	+65°	η Ursæ Maj.	177°	−24°	β Orionis (Rigel)	300°	−9°	ζ Aræ
79°	+41°	β Ursæ Min.	182°	+15°	α Canis Min. (Procyon)	313°	−59°	β Gruis
78°	+62°	ζ Ursæ Maj. (Mizar)	195°	+50°	α Leonis (Regulus)	317°	−54°	α Gruis
87°	+61°	ε Ursæ Maj.	195°	−8°	α Canis Maj. (Sirius)	320°	+14°	α Scorpii (Antares)
88°	−81°	β Ceti	205°	+66°	θ Leonis	321°	+22°	β Scorpii
90°	+27°	α Ursæ Min. (Polaris)	210°	+30°	α Hydræ (Alphard)	327°	−11°	ε Sagittarii
91°	−2°	γ Cassiopeiæ	210°	−5°	η Canis Maj.	343°	+68°	α Boötis (Arcturus)
98°	+60°	δ Ursæ Maj.	222°	+72°	β Leonis (Denebola)	348°	−66°	α Pisc. A. (Fomalhaut)
109°	+52°	α Ursæ Maj. (Dubhe)	228°	−25°	α Carinæ (Canopus)	355°	+4°	η Serpentis

Apparent (Sundial) Time of Sunset.—To obtain Mean Time of Sunset, see opposite. E.=Equation of Time.

Northern Latitudes				0°	10°	20°	30°	35°	40°	45°	50°	52°	54°	56°	58°	60°	Southern Latitudes			
Date	E.	Date	E.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	Date	E.	Date	E.
Dec. 21	-2	Dec. 21	-2	6 04	5 46	5 28	5 06	4 54	4 40	4 23	4 02	3 52	3 41	3 28	3 14	2 56	Jun. 21	+1	Jun. 21	+1
„ 24	-1	„ 19	3	6 04	5 47	5 28	5 07	4 55	4 40	4 23	4 03	3 53	3 42	3 29	3 14	2 57	„ 24	2	„ 18	1
„ 27	+1	„ 16	5	6 04	5 47	5 28	5 07	4 55	4 40	4 24	4 03	3 54	3 43	3 30	3 15	2 58	„ 27	3	„ 16	0
„ 30	2	„ 14	6	6 04	5 47	5 28	5 07	4 55	4 41	4 25	4 04	3 55	3 44	3 31	3 16	2 59	„ 30	3	„ 13	0
Jan. 1	3	„ 11	7	6 04	5 47	5 29	5 08	4 56	4 42	4 26	4 05	3 56	3 45	3 33	3 18	3 01	July 3	4	„ 10	-1
„ 4	5	„ 8	8	6 04	5 47	5 29	5 08	4 57	4 43	4 27	4 07	3 57	3 46	3 35	3 21	3 04	„ 6	4	„ 7	2
„ 7	6	„ 5	10	6 04	5 47	5 30	5 09	4 58	4 44	4 28	4 09	4 00	3 49	3 38	3 24	3 08	„ 9	5	June 3	2
„ 10	7	Dec. 2	11	6 04	5 48	5 31	5 11	4 59	4 46	4 30	4 12	4 03	3 53	3 41	3 28	3 13	„ 12	5	May 31	3
„ 13	8	Nov. 29	12	6 04	5 48	5 32	5 12	5 01	4 48	4 33	4 15	4 06	3 56	3 45	3 33	3 18	„ 15	6	„ 28	3
„ 16	10	„ 26	13	6 04	5 48	5 32	5 13	5 02	4 50	4 36	4 17	4 09	3 59	3 49	3 37	3 23	„ 19	6	„ 25	3
„ 19	11	„ 23	14	6 04	5 49	5 33	5 15	5 04	4 52	4 39	4 21	4 13	4 03	3 54	3 42	3 29	„ 22	6	„ 22	4
„ 22	11	„ 20	15	6 04	5 50	5 34	5 17	5 07	4 55	4 42	4 25	4 18	4 08	3 59	3 48	3 36	„ 25	6	„ 19	4
„ 25	12	„ 17	15	6 04	5 50	5 35	5 19	5 09	4 58	4 45	4 29	4 22	4 14	4 05	3 54	3 42	„ 28	6	„ 15	4
„ 28	13	„ 14	16	6 04	5 51	5 36	5 20	5 11	5 01	4 48	4 33	4 26	4 19	4 10	4 00	3 49	„ 31	6	„ 12	4
„ 31	13	„ 11	16	6 04	5 51	5 38	5 22	5 14	5 04	4 52	4 38	4 31	4 24	4 16	4 07	3 56	Aug. 3	+6	„ 9	4
Feb. 3	+14	„ 8	-16	6 04	5 52	5 39	5 24	5 16	5 07	4 56	4 43	4 36	4 30	4 22	4 13	4 04	„ 7	6	„ 6	3
„ 6	14	„ 5	16	6 04	5 52	5 40	5 27	5 19	5 10	5 00	4 48	4 42	4 36	4 28	4 20	4 12	„ 10	5	May 3	3
„ 9	14	Nov. 2	16	6 04	5 53	5 42	5 29	5 22	5 14	5 04	4 53	4 48	4 42	4 35	4 27	4 19	„ 13	5	Apr. 30	3
„ 12	14	Oct. 30	16	6 04	5 54	5 44	5 32	5 25	5 18	5 09	4 58	4 53	4 48	4 42	4 35	4 27	„ 16	4	„ 27	2
„ 15	14	„ 27	16	6 04	5 55	5 45	5 34	5 28	5 21	5 13	5 03	4 59	4 54	4 48	4 42	4 35	„ 19	4	„ 24	2
„ 18	14	„ 24	16	6 04	5 55	5 46	5 36	5 31	5 24	5 17	5 08	5 04	5 00	4 55	4 49	4 43	„ 22	3	„ 21	-1
„ 21	14	„ 21	15	6 03	5 56	5 48	5 39	5 34	5 28	5 21	5 14	5 10	5 06	5 01	4 56	4 51	„ 26	2	„ 18	0
„ 24	13	„ 18	15	6 03	5 56	5 50	5 42	5 37	5 32	5 26	5 19	5 16	5 13	5 08	5 04	4 59	„ 29	+1	„ 15	0
„ 27	13	„ 15	14	6 03	5 57	5 51	5 44	5 40	5 36	5 31	5 25	5 22	5 19	5 15	5 11	5 07	Sept. 1	0	„ 12	+1
Mar. 2	12	„ 12	-13	6 03	5 58	5 53	5 47	5 43	5 40	5 36	5 30	5 28	5 26	5 22	5 19	5 15	„ 4	-1	„ 9	2
„ 5	+12	„ 9	12	6 03	5 59	5 54	5 49	5 46	5 43	5 40	5 35	5 33	5 32	5 29	5 26	5 23	„ 7	2	„ 5	3
„ 8	11	„ 6	12	6 03	6 00	5 56	5 52	5 50	5 47	5 45	5 41	5 39	5 38	5 36	5 34	5 32	„ 10	3	Apr. 2	4
„ 11	10	Oct. 3	11	6 03	6 01	5 58	5 55	5 54	5 51	5 50	5 47	5 45	5 45	5 43	5 42	5 40	„ 13	4	Mar. 30	5
„ 14	10	Sep. 30	10	6 03	6 01	5 59	5 57	5 57	5 55	5 54	5 52	5 51	5 51	5 50	5 49	5 48	„ 16	5	„ 27	6
„ 17	9	„ 27	9	6 03	6 02	6 01	6 00	6 00	5 59	5 59	5 58	5 58	5 57	5 57	5 57	5 56	„ 19	6	„ 25	6
„ 20	8	„ 24	8	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 04	„ 22	7	„ 22	7
„ 23	7	„ 21	7	6 03	6 04	6 05	6 06	6 06	6 07	6 08	6 09	6 10	6 11	6 11	6 12	6 13	„ 25	8	„ 19	8
„ 26	6	„ 18	5	6 03	6 05	6 07	6 09	6 10	6 11	6 13	6 15	6 16	6 17	6 18	6 19	6 21	„ 28	-9	„ 16	9
„ 29	5	„ 15	4	6 03	6 06	6 08	6 11	6 13	6 15	6 18	6 21	6 22	6 24	6 25	6 27	6 29	Oct. 2	10	„ 13	10
Apr. 1	+4	„ 11	3	6 03	6 06	6 10	6 14	6 16	6 19	6 22	6 26	6 28	6 30	6 32	6 35	6 38	„ 5	11	„ 9	11
„ 4	3	„ 8	2	6 03	6 07	6 12	6 17	6 20	6 23	6 27	6 32	6 34	6 37	6 39	6 43	6 46	„ 8	12	„ 6	12
„ 7	2	„ 5	-1	6 03	6 08	6 13	6 20	6 23	6 27	6 32	6 38	6 40	6 44	6 46	6 50	6 54	„ 11	13	Mar. 3	12
„ 10	2	Sept. 2	0	6 03	6 08	6 14	6 22	6 26	6 31	6 36	6 43	6 46	6 50	6 53	6 57	7 02	„ 13	13	Feb. 28	+13
„ 13	+1	Aug 30	+1	6 03	6 09	6 16	6 24	6 29	6 35	6 41	6 48	6 52	6 56	7 00	7 05	7 10	„ 16	14	„ 25	13
„ 16	0	„ 27	2	6 03	6 10	6 18	6 27	6 32	6 39	6 46	6 54	6 58	7 02	7 07	7 12	7 18	„ 19	15	„ 22	14
„ 19	-1	„ 24	3	6 03	6 11	6 20	6 30	6 35	6 43	6 50	7 00	7 04	7 09	7 14	7 20	7 26	„ 22	15	„ 20	14
„ 22	1	„ 21	3	6 03	6 12	6 21	6 32	6 38	6 46	6 54	7 05	7 09	7 15	7 20	7 27	7 34	„ 25	16	„ 17	14
„ 25	2	„ 18	4	6 04	6 13	6 23	6 35	6 41	6 50	6 59	7 10	7 15	7 21	7 27	7 34	7 42	„ 28	16	„ 14	14
„ 28	2	„ 15	5	6 04	6 13	6 24	6 37	6 44	6 53	7 03	7 15	7 20	7 27	7 33	7 41	7 50	„ 31	16	„ 11	14
May 1	-3	„ 12	+5	6 04	6 14	6 26	6 40	6 47	6 57	7 07	7 20	7 26	7 33	7 40	7 49	7 58	Nov. 3	-16	„ 8	14
„ 4	3	„ 9	6	6 04	6 15	6 27	6 42	6 50	7 00	7 11	7 25	7 31	7 39	7 47	7 56	8 06	„ 6	16	„ 5	14
„ 7	3	„ 6	6	6 04	6 15	6 28	6 44	6 53	7 03	7 15	7 30	7 36	7 44	7 53	8 02	8 14	„ 9	16	Feb. 2	14
„ 10	4	Aug. 3	6	6 04	6 16	6 31	6 46	6 56	7 07	7 19	7 35	7 42	7 50	7 59	8 09	8 22	„ 12	16	Jan. 31	13
„ 13	4	July 31	6	6 04	6 17	6 32	6 48	6 58	7 10	7 23	7 39	7 47	7 55	8 05	8 16	8 29	„ 15	15	„ 28	13
„ 16	4	„ 28	6	6 04	6 18	6 33	6 50	7 01	7 12	7 26	7 43	7 52	8 00	8 11	8 22	8 36	„ 17	15	„ 25	12
„ 19	4	„ 25	6	6 04	6 18	6 34	6 52	7 03	7 15	7 30	7 47	7 56	8 05	8 16	8 28	8 43	„ 20	15	„ 22	11
„ 22	4	„ 22	6	6 04	6 19	6 35	6 54	7 05	7 18	7 33	7 51	8 00	8 10	8 21	8 34	8 50	„ 23	14	„ 19	11
„ 25	3	„ 19	6	6 04	6 19	6 36	6 55	7 06	7 20	7 35	7 54	8 04	8 14	8 26	8 39	8 56	„ 26	13	„ 16	10
„ 28	3	„ 16	6	6 04	6 20	6 37	6 57	7 08	7 22	7 38	7 58	8 08	8 18	8 30	8 44	9 01	„ 29	12	„ 14	9
„ 31	3	„ 13	5	6 04	6 20	6 38	6 58	7 10	7 24	7 41	8 01	8 11	8 22	8 34	8 49	9 07	Dec. 2	11	„ 11	8
June 3	-2	„ 10	5	6 04	6 20	6 38	6 59	7 11	7 26	7 42	8 03	8 14	8 25	8 38	8 53	9 12	„ 5	10	„ 8	6
„ 6	2	„ 7	5	6 04	6 21	6 39	7 00	7 13	7 27	7 44	8 05	8 16	8 28	8 41	8 57	9 16	„ 7	-9	„ 5	5
„ 9	-1	„ 4	4	6 04	6 21	6 39	7 01	7 13	7 28	7 46	8 07	8 18	8 30	8 44	9 00	9 19	„ 10	8	Jan. 2	+4
„ 12	-1	July 1	3	6 04	6 21	6 40	7 02	7 14	7 29	7 47	8 09	8 20	8 32	8 46	9 03	9 22	„ 13	6	Dec. 31	3
„ 15	0	Jun. 28	3	6 04	6 21	6 40	7 02	7 15	7 30	7 48	8 10	8 21	8 33	8 48	9 04	9 24	„ 16	5	„ 28	+1
„ 18	+1	„ 25	2	6 04	6 21	6 40	7 02	7 15	7 30	7 48	8 11	8 22	8 34	8 48	9 05	9 26	„ 19	3	„ 25	0
Jun. 21	+1	Jun. 21	+1	6 04	6 22	6 41	7 03	7 16	7 31	7 49	8 12	8 23	8 35	8 49	9 06	9 27	Dec. 21	-2	Dec. 21	-2

Duration of Twilight (Table I).—See Note on page 38. (For fuller Tables, see *Nautical Almanac*).

Latitude,	0°	10°	20°	30°	40°	45°	50°	55°	60°
Winter Solstice	1h 16m	1h 16m	1h 19m	1h 25m	1h 38m	1h 47m	1h 59m	2h 17m	2h 46m
Equinoxes ...	1 9	1 10	1 13	1 19	1 30	1 39	1 50	2 4	2 25
Summer Solstice	1 15	1 18	1 25	1 36	2 03	2 33	Lasts from	Sunset to	Sunrise.

Apex of glow above horizon, 1 hr. after sunset, Dec. 21, *about* 7°   8°   9°   10°   12°

Semi-diurnal Arcs (II), or Time between Rising or Setting, and Culmination. (Refraction not allowed for).

N. Hemisphere observers read the star's N. or S. Declination at the *top* of the column; those in the S. Hemisphere, at the *foot*.

N. Hemisphere:—STARS WITH NORTH DECLINATION.

Observ. Lat.	30°	25°	20°	15°	10°	5°	0°
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
5°	6 11	6 8	6 7	6 5	6 4	6 2	6 0
10	6 23	6 19	6 15	6 11	6 7	6 4	6 0
15	6 36	6 29	6 22	6 16	6 11	6 5	6 0
20	6 49	6 39	6 30	6 22	6 15	6 7	6 0
25	7 2	6 49	6 39	6 29	6 19	6 9	6 0
30	7 19	7 2	6 49	6 36	6 23	6 12	6 0
35	7 35	7 16	6 59	6 43	6 28	6 14	6 0
40	7 55	7 32	7 11	6 52	6 34	6 17	6 0
45	8 18	7 51	7 25	7 2	6 41	6 20	6 0
50	8 53	8 15	7 43	7 14	6 49	6 24	6 0
55	9 39	8 47	8 5	7 30	6 58	6 29	6 0
60°	11 22	9 35	8 36	7 51	7 11	6 35	6 0

N. Hemisphere:—STARS WITH S. DECLINATION.

Observ. Lat.	5°	10°	15°	20°	25°	30°	Observ. Lat.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	
5°	5 58	5 56	5 55	5 53	5 52	5 49	5°
10	5 56	5 53	5 49	5 45	5 41	5 37	10
15	5 55	5 49	5 44	5 38	5 31	5 24	15
20	5 53	5 45	5 38	5 30	5 21	5 11	20
25	5 51	5 41	5 31	5 21	5 11	4 58	25
30	5 48	5 37	5 24	5 11	4 58	4 41	30
35	5 46	5 32	5 17	5 1	4 44	4 25	35
40	5 43	5 26	5 8	4 49	4 28	4 5	40
45	5 40	5 19	4 58	4 35	4 9	3 42	45
50	5 36	5 11	4 46	4 17	3 45	3 7	50
55	5 31	5 2	4 30	3 55	3 13	2 21	55
60°	5 25	4 49	4 9	3 24	2 25	0 38	60°

S. Hemisphere:—STARS with SOUTH DECLINATION.   S. Hemisphere:—STARS with N. DECLINATION.

Rising or Setting of Stars, &c.—From the R.A., find culmination-time (Table III), then for *Rising* Subtract, for *Setting* Add the semi-diurnal arc for the Dec. and observer's latitude. *Ex.* Rising of Leo on Nov. 13, in lat. 55°N.; R.A. 10h., Dec. 20°N.?
On Nov. 14 (after midnight, 13th), as R.A. 9½h. souths at 6 a.m., 10h. souths at 6.30 a.m. Semi-diurnal arc for Dec. 20° N. and 55° N. is 8h. 5m., which subtracted from 6.30 a.m. gives 10.25 p.m. on Nov. 13th as the rising-time of Leo.

When does Mars rise on Mar. 28 in lat. 45° N.? R.A. 13½h., Dec. 5° S. (*a*) Proceed as above. Or (*b*) Find in the *N.A.* the time of meridian passage on Mar. 28, say 1 a.m. (29th), from which subtract the semi-diurnal arc 5 h. 40 m. Answer, 7.20 p.m.

To find when a Star is on the Meridian.—(The R.A. Central Meridian of each Chart is given at the side).
When will the constellation Taurus be south at 10 p.m.? From the Index of Constellations (last page)
Taurus is in Map 5 : the central meridian of Taurus is R.A. 4 h. (see also at side). In Table III below,
Sidereal Time, in the column headed 10 p.m., and in line with R.A. 4 h., is the date required, Dec. 21.

Central Meridian Maps	= R.A.
3-4	24 h.
5-6	4 h.
7-8	8 h.
9-10	12 h.
11-12	16 h.
13-14	20 h.

What constellations are in the south at 8 p.m. on March 22nd? In Table III find March 22; in the column headed 8 p.m., in same line, is the answer R.A. 8 h., contained in Maps 7-8 :—Gemini, Cancer, &c.

When will R.A. 6h. culminate on March 7? *Answer* (Table III), 7 p.m.—March 7 line, above R.A. 6h.

Sidereal Time (III), or Hour of R.A. on the Meridian.—If time is after midnight, add 1 day to the date at the side.

Intermediate Dates. Add to the R.A. for the previous date the requisite No. of minutes from the 7- or 8-day-interval Table below.

7 Days Interval:—1 day   2 dys.   3 dys.   4 dys.   5 dys.   6 days.   8 Days Interval. 1 day   2 dys.   3 dys.   4 dys.   5 dys.   6 dys.   7 dys.
Add minutes, 4 m.   9 m.   13 m.   17 m.   21 m.   26 m.   Add minutes, 4 m.   8 m.   12 m.   15 m.   19 m.   23 m.   26 m.

Intermediate Minutes of Mean Time. Add the same No. of R.A. minutes to the previous R.A. hour. Thus Apr. 6 at 5.9 p.m. = R.A. 6 h. 9m.

Hour of R.A. on the Meridian at:—

Date	5p.m.	6p.	7p.	8p.	9p.	10p.	11p.	12a.	1a.	2a.	3a.	4a.	5a.	6a.
Jan. 5	0h.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10	11	12	13
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	1	2	3	4	5	6	7	8	9	10	11	12	13	14
28	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Feb. 5	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
20	3	4	5	6	7	8	9	10	11	12	13	14	15	16
28	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Mar. 7	4	5	6	7	8	9	10	11	12	13	14	15	16	17
15	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	5	6	7	8	9	10	11	12	13	14	15	16	17	18
29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Apr. 6	6	7	8	9	10	11	12	13	14	15	16	17	18	19
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	7	8	9	10	11	12	13	14	15	16	17	18	19	20
29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
May 7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
15	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	9	10	11	12	13	14	15	16	17	18	19	20	21	22
30	½	½	½	½	½	½	½	½	½	½	½	½	½	½
June 6	10	11	12	13	14	15	16	17	18	19	20	21	22	23
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	11	12	13	14	15	16	17	18	19	20	21	22	23	0
Jun. 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½

Hour of R.A. on the Meridian at:—

Date	5p.m.	6p.	7p.	8p.	9p.	10p.	11p.	12a.	1a.	2a.	3a.	4a.	5a.	6a.
Jul. 7	12	13	14	15	16	17	18	19	20	21	22	23	0h.	1h
15	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	13	14	15	16	17	18	19	20	21	22	23	0	1	2
30	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Aug. 6	14	15	16	17	18	19	20	21	22	23	0	1	2	3
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	15	16	17	18	19	20	21	22	23	0	1	2	3	4
29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Sept. 6	16	17	18	19	20	21	22	23	0	1	2	3	4	5
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	17	18	19	20	21	22	23	0	1	2	3	4	5	6
29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Oct. 6	18	19	20	21	22	23	0	1	2	3	4	5	6	7
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	19	20	21	22	23	0	1	2	3	4	5	6	7	8
29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Nov. 6	20	21	22	23	0	1	2	3	4	5	6	7	8	9
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	21	22	23	0	1	2	3	4	5	6	7	8	9	10
28	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Dec. 6	22	23	0	1	2	3	4	5	6	7	8	9	10	11
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	23	0	1	2	3	4	5	6	7	8	9	10	11	12
Dec. 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½

Decimals of a Degree.—For valuing minutes and seconds of arc to the nearest 1/100th of a degree, and *vice versa*. (The *exact* equivalent of ·01 degree is 36″). Take the decimal equivalent just *less* than the value to be converted ; or *vice versa*, the Tabular value *plus* 18″, which gives the exact value of 100ths of a degree. Thus 33′ 48″ = 0°·56 approx.; ·0°·43 = 25′ 48″.

·01	0′18″	·11	6′18″	·21	12′18″	·31	18′18″	·41	24′18″	·51	30′18″	·61	36′18″	·71	42′18″	·81	48′18″	·91	54′18″
·02	0 54	·12	6 54	·22	12 54	·32	18 54	·42	24 54	·52	30 54	·62	36 54	·72	42 54	·82	48 54	·92	54 54
·03	1 30	·13	7 30	·23	13 30	·33	19 30	·43	25 30	·53	31 30	·63	37 30	·73	43 30	·83	49 30	·93	55 30
·04	2 6	·14	8 6	·24	14 6	·34	20 6	·44	26 6	·54	32 6	·64	38 6	·74	44 6	·84	50 6	·94	56 6
·05	2 42	·15	8 42	·25	14 42	·35	20 42	·45	26 42	·55	32 42	·65	38 42	·75	44 42	·85	50 42	·95	56 42
·06	3 18	·16	9 18	·26	15 18	·36	21 18	·46	27 18	·56	33 18	·66	39 18	·76	45 18	·86	51 18	·96	57 18
·07	3 54	·17	9 54	·27	15 54	·37	21 54	·47	27 54	·57	33 54	·67	39 54	·77	45 54	·87	51 54	·97	57 54
·08	4 30	·18	10 30	·28	16 30	·38	22 30	·48	28 30	·58	34 30	·68	40 30	·78	46 30	·88	52 30	·98	58 30
·09	5 6	·19	11 6	·29	17 6	·39	23 6	·49	29 6	·59	35 6	·69	41 6	·79	47 6	·89	53 6	·99	59 6
·10	5′42′	·20	11′42″	·30	17′42″	40°	23′42″	·50°	29′42″	·60°	35′42″	·70°	41′42″	·80°	47′42″	·90°	53′42″	1°	59′42″

Decimals of a Day.—The decimals of a minute for columns 2-10 are the same as those, *in the same line*, of the 1st column.

Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. h. m.		Dec. min.	
·01	0 14·4	·11	2 38	·21	5 2	·31	7 26	·41	9 50	·51	12 14	·61	14 38	·71	17 2	·81	19 26	·91	21 50	·001	1·44
·02	0 28·8	·12	2 52	·22	5 16	·32	7 40	·42	10 4	·52	12 28	·62	14 52	·72	17 16	·82	19 40	·92	22 4	·002	2·88
·03	0 43·2	·13	3 7	·23	5 31	·33	7 55	·43	10 19	·53	12 43	·63	15 7	·73	17 31	·83	19 55	·93	22 19	·003	4·32
·04	0 57·6	·14	3 21	·24	5 45	·34	8 9	·44	10 33	·54	12 57	·64	15 21	·74	17 45	·84	20 9	·94	22 33	·004	5·76
·05	1 12·0	·15	3 36	·25	6 0	·35	8 24	·45	10 48	·55	13 12	·65	15 36	·75	18 0	·85	20 24	·95	22 48	·005	7·20
·06	1 26·4	·16	3 50	·26	6 14	·36	8 38	·46	11 2	·56	13 26	·66	15 50	·76	18 14	·86	20 38	·96	23 2	·006	8·64
·07	1 40·8	·17	4 4	·27	6 28	·37	8 52	·47	11 16	·57	13 40	·67	16 4	·77	18 28	·87	20 52	·97	23 16	·007	10·08
·08	1 55·2	·18	4 19	·28	6 43	·38	9 7	·48	11 31	·58	13 55	·68	16 19	·78	18 43	·88	21 7	·98	23 31	·008	11·52
·09	2 9·6	·19	4 33	·29	6 57	·39	9 21	·49	11 45	·59	14 9	·69	16 33	·79	18 57	·89	21 21	·99	23 45	·009	12·96
·10	2 24·0	·20	4 48	·30	7 12	·40	9 36	·50	12 0	·60	14 24	·70	16 48	·80	19 12	·90	21 36	1·0	24 0	·010	14·40

Hours and Minutes as Decimals of a Day.

Hrs.	½hr.	1h.	1½h.	2h.	2½h.	3h.	3½h.	4h.	4½h.	5h.	5½h.	6h.	6½h.	7h.	7½h.	8h.	8½h.	9h.
=	·0208	·0417	·0625	·0833	·1042	·1250	·1458	·1667	·1875	·2083	·2292	·2500	·2708	·2917	·3125	·3333	·3542	·3750

	9½h.	10h.	10½h.	11h.	11½h.	12h.	12½h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.
=	·3958	·4167	·4375	·4583	4792	·5000	·5208	·5417	·5833	·6250	·6667	·7083	·7500	·7917	·8333	·8750	·9167	·9583

Minutes:—	1m.	2m.	3m.	4m.	5m.	6m.	7m.	8m.	9m.	10m.	11m.	12m.	13m.	14m.	15m.	16m.	17m.
Decimal =	·0007	·0014	·0021	·0028	·0035	·0042	·0049	·0056	·0062	·0069	·0076	·0083	·0090	·0097	·0104	·0111	·0118

	18m.	19m.	20m.	21m.	22m.	23m.	24m.	25m.	26m.	27m.	28m.	29m.	30m.	35m.	40m.	45m.	50m.	55m.
=	·0125	·0132	·0139	·0146	·0153	·0160	·0167	·0174	·0181	·0187	·0194	·0201	·0208	·0243	·0278	·0313	·0347	·0382

PRECESSION TABLES

Precession in R.A. for 10 Years. For Northern objects use the upper line of R.A. Hours; for Southern objects, the lower. The ± signs are added algebraically to the catalogue positions, like signs being added, unlike signs subtracted. For reckoning backwards, to an earlier date, reverse the + or − signs.

Hours of Right Ascension for NORTHERN Objects.

Dec.	0,12	1,11	2,10	3,9	4,8	5,7	6	18	19,17	20,16	21,15	22,14	23,13	Dec.
80°	+0·51m	+0·84m	+1·14m	+1·40m	+1·60m	+1·73m	+1·77m	−0·75m	−0·70m	−0·58m	−0·38m	−0·12m	+0·19m	80°
70°	0·51	0·67	0·82	0·94	1·04	1·10	1·12	−0·10	−0·08	−0·02	+0·08	+0·21	0·35	70°
60°	0·51	0·61	0·70	0·78	0·84	0·88	0·90	+0·13	+0·14	+0·18	+0·24	+0·32	0·41	60°
50°	0·51	0·58	0·64	0·70	0·74	0·77	0·78	+0·25	+0·26	+0·28	+0·32	+0·38	0·44	50°
40°	0·51	0·56	0·61	0·64	0·67	0·69	0·70	+0·33	+0·33	+0·35	+0·38	+0·42	0·46	40°
30°	0·51	0·54	0·58	0·60	0·62	0·64	0·64	+0·38	+0·39	+0·40	+0·42	+0·45	0·48	30°
20°	0·51	0·53	0·55	0·57	0·58	0·59	0·59	+0·43	+0·43	+0·44	+0·45	+0·47	0·49	20°
10°	0·51	0·52	0·53	0·54	0·55	0·55	0·55	+0·47	+0·47	+0·48	+0·48	+0·49	0·50	10°
0°	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	0·51m	0°
Dec.	0,12	23,13	22,14	21,15	20,16	19,17	18	6	5,7	4,8	3,9	2,10	1,11	Dec.

Hours of Right Ascension for SOUTHERN Objects.

Precession in Declination for 10 Years for objects having N. Declination. S. Declination, reverse the + or − signs.

Hours	0,24	1,23	2,22	3,21	4,20	5,19	6,18	7,17	8,16	9,15	10,14	11,13	12
	+3′·3	+3′·2	+2′·9	+2′·4	+1′·7	+0′·9	0	−0′·9	−1′·7	−2′·4	−2′·9	−3′·2	−3′·3

Example :—The Star α Ursæ Majoris is placed in 1920 in R.A. 10h. 58·9m., Declination +62° 11′; find its approximate position in 1950.

Turn to the column headed by the nearest R.A. hour, 11. In this column the 10-year R.A. correction for 60°N. is +0·61m., for 70°N. it is +0·67m., giving about +0·62m. for the intermediate Dec. of the Star.

R.A. of α Ursæ Majoris for 1920   is   10h. 58·9m.
Correction for 30 years (+0·62 × 3)   ,,   + 1·9m.
R.A. for 1950   11h. 0·8m.

The Star's Declination for 1920   is   62° 11′
Correction for 30 years (−3′·2 × 3)   ,,   −10′
Dec. for 1950   62° 1′

Astronomical Signs or Symbols (occasionally-used symbols in brackets) :—

Signs of the Zodiac.   Aries   Taurus   Gemini   Cancer   Leo   Virgo   Libra   Scorpius   Sagittarius   Capricornus   Aquarius   Pisces

   Symbol.   ♈   ♉   ♊   ♋   ♌   ♍   ♎   ♏   ♐   ♑   ♒   ♓

Sun, &c.— Sun   Mercury   Venus   Earth   Moon   Mars   Minor planet   Jupiter   Saturn   Uranus   Neptune   Pluto   Comet   Star

   Symbol. ⊙ (○)   ☿   ♀   ⊕ (♁)   ☽   ♂   ⑨   ♃   ♄   ♅, ♁   ♆   ♇   ☄   ✳

Other Signs. 1st of Aries, Conjunction, Quadrature, Opposition. Node (longit. of). **Moon's Phases :—** New, 1st qr., Full, 3rd qr.

   Symbol. ... ♈   ☌   □   ☍   ☊ ascending   ...   ●   ☽   ○   ☾

   Longit. fr. Sun, = 0°   90°   180°   ☋ descending.   Longit. from Sun, = 0°   90°   180°   270°

Symbols of Elements.— *A*, Argon ; *Al*, Aluminium ; *Be*, Beryllium ; *C*, Carbon ; *Ca*, Calcium ; *Cr*, Chromium ; *Fe*, Iron ; *H*, Hydrogen ; *He*, Helium ; *K*, Potasssium ; *Li*, Lithium ; *Mg*, Magnesium ; *Mn*, Manganese ; *N*, Nitrogen ; *Na*, Sodium ; *Ne*, Neon ; *O*, Oxygen ; *P*, Phosphorus ; *Rb*, Rubidium ; *S*, Sulphur ; *Sc*, Scandium ; *Si*, Silicon ; *Sr*, Strontium ; *Ti*, Titanium ; *Zr*, Zirconium.

Significance of + and −. For Direction, + indicates (*a*) northwards; (*b*) 'direct' or 'positive' motion —*i.e*, to the left, or eastwards, when looking south : − indicates (*a*) southwards ; (*b*) 'retrograde' or 'negative' motion—*i.e.*, to the right, or westwards when looking south. **Variable Stars :** + indicates that a maximum or minimum is later than the predicted date ; −, that it is earlier. **Comets :** as for Variable stars, + later, − earlier, to indicate departure from the ephemeris, or the elements.

Earth's Areo-, and Zenographic Dec.— When +, the planet's North pole is presented to the Earth; when −, the South pole.

Declination :—	**Libration ; mean centre :—**	**Position Angle Sun's Axis :—**	**Radial Velocity :—**
+ = North of Celestial eqr.	+ = Displaced to E. (longit.)	+ = N. Pole, E. ⎱ of the Hr.	+ = Recession from Sun.
− = South „ „	− „ „ W. „	− = „ W. ⎰ Circle.	− = Approach to „
Latitude :—	+ = Displaced to S. (lat.)	**Proper Motion, Precession :—**	**Saturn's Rings :—** (p. 32).
+ = N. ⎱ of Ecliptic, or of	− „ „ N. „	+ = Northwards (in Dec.)	+ = Earth N. of ring-plane.
− = S. ⎰ Earth's or Galact.	(see note, p. 29)	− = Southwards „	− = „ S. „ „
Longitude :— [eqr.	**Magnitude :—**	+ = Direct (in R.A.)	**Sun's Equator :—** (p. 40).
+ = W. ⎱ of Greenwich.	+ = Fainter than mag. 0·0	− = Retrograde „	+ = S. of centre of disc.
− = E. ⎰	− = Brighter „ „ 0·0	**Light-time.** + later, − earlier.	− = N. „ „

Astronomical Contractions.— Those for Astronomical Societies, Publications, Star catalogues, &c., are given on pp. vi-vii.

Æ Right Ascension	G.C.T. Greenwich Civil Time	K. Kelvin (Abs. temp., p. 17).	P.M. Proper Motion
A.U. Astronomical Unit	G.M.A.T. „ Mean Astron. Time	Lat. Latitude	R.A. Right Ascension
„ Angstrom Unit	G.M.N. Greenwich Mean Noon	Long. Longitude	U.T., T.U.* Universal Time
C.I. Colour index	G.M.T. „ „ Time	Mag. Magnitude	S.D. Semi-diameter
C.M. Central Meridian	H.I. Heat Index	N.P.D. North Polar Distance	Z.D. Zenith distance
Dec. Declination	H.P. Horizontal parallax	N.P.S. „ „ Sequence	*nf* North following.
Eqr. Equator	I.A. International Angstrom	O. − C. Observed − calculated	*np* „ preceding.
Gal. Galactic	J.D., J.P., Julian Day & Period	P.A. Position Angle	*sp* South preceding.
G.E. Greatest elongation	J.A.D. „ Astr. Day, p. 9.	P.E. Probable error	*sf* „ following.

d, days ; *h.*, hours ; *m.*, minutes ; *s.* seconds.   *mm.*, millimetres ; *cm.*, centimetres ; *km.*, kilometres.   *l/y*, light-years.

Astronomical Symbols for Positions, Magnitudes, Parallaxes, &c. (fuller list facing front cover).   (I.A.U. proposed, 1935).

α Right Ascension	*Az* Azimuth, *h* Altitude	λ Wave-length, in Angstroms, p. 22	*M* Magnitude, absolute
δ Declination	*z* Zenith Distance	μ Micron, = 1/1000th mm.	*m* „ apparent
β Latitude (celestial), geocent.	*H* or *t* Hour Angle	= λ10,000	m_v „ „ visual
λ Longitude „ „	π Parallax, annual, in ″.	μμ 1/millionth mm. = λ10	m_{pv} „ „ photovisual
G Galactic longitude	P_0 „ equatorial horizontal	ε Obliquity of Ecliptic	m_{pg} „ „ photographic
g „ latitude	*p* Annual precession (general)	*P* Orbital period	m_{ipg} „ „ internat. pg.
b Heliocentric latitude	*p* Position angle, p. 5.	*E* Time, Equation of	m_{bol} „ „ bolometric
l „ longitude	μ Proper motion (total annual)	*t* „ of observation	m_{rad} „ „ radiometric
φ Geographical latitude: φ′ geo-	*R, T, W,* Velocity,+ radial (re-	t_m „ mean : t_v True time.‡	m_{pr} „ „ photo-red
L „ longitude, + W. [centric	ceding +), tangential, spatial.	θ „ sidereal: $θ_0$ at mean midnight	m_{pir} „ „ infra-red

Constellation Abbreviations. Three- and four-letter contractions (Int. Astr. Union, 1922, -32). (Malus replaced by Pyxis.

And	Andromeda	Andr	Cha	Chamæleon	Cham	Eri	Eridanus	Erid	Men	Mensa	Mens	Scl	Sculptor	Scul
Ant	Antlia	Antl	Cir	Circinus	Circ	For	Fornax	Forn	Mic	Microscop'm	Micr	Sco	Scorpius	Scor
Aps	Apus	Apus	CMa	Canis Maj.	C Maj	Gem	Gemini	Gemi	Mon	Monoceros	Mono	Sct	Scutum	Scut
Aql	Aquila	Aqil	CMi	Canis Min.	C Min	Gru	Grus	Grus	Mus	Musca	Musc	Ser	Serpens	Serp
Aqr	Aquarius	Aqar	Cnc	Cancer	Canc	Her	Hercules	Herc	Nor	Norma	Norm	Sex	Sextans	Sext
Ara	Ara	Arie	Col	Columba	Colm	Hor	Horologium	Horo	Oct	Octans	Octn	Sge	Sagitta	Sgte
Arg	Argo	Argo	Com	Coma Ber.	Coma	Hya	Hydra	Hyda	Oph	Ophiuchus	Ophi	Sgr	Sagittarius	Sgtr
Ari	Aries	Arie	CrA	Corona Aus.	Cor A	Hyi	Hydrus	Hydi	Ori	Orion	Orio	Tau	Taurus	Taur
Aur	Auriga	Auri	CrB	Corona Bor.	Cor B	Ind	Indus	Indi	Pav	Pavo	Pavo	Tel	Telescop'm	Tele
Boo	Boötes	Boot	Crt	Crater	Crat	Lac	Lacerta	Lacr	Peg	Pegasus	Pegs	TrA	Triang. Aus.	Tr Au
Cae	Caelum	Cæl	Cru	Crux	Cruc	Leo	Leo	Leon	Per	Perseus	Pers	Tri	Triangulum	Tria
Cam	Camelopard.	Caml	Crv	Corvus	Corv	Lep	Lepus	Leps	Phe	Phœnix	Phœ	Tuc	Tucana	Tucn
Cap	Capricornus	Capr	CVn	Canes Ven.	C Ven	Lib	Libra	Libr	Pic	Pictor	Pict	UMa	Ursa Major	U Maj
Car	Carina	Cari	Cyg	Cygnus	Cygn	LMi	Leo Minor	L Min	PsA	Piscis Aust.	Psc A	UMi	Ursa Minor	U Min
Cas	Cassiopeia	Cass	Del	Delphinus	Dlph	Lup	Lupus	Lupi	Psc	Pisces	Pisc	Vel	Vela	Velr
Cen	Centaurus	Cent	Dor	Dorado	Dora	Lyn	Lynx	Lync	Pup	Puppis	Pupp	Vir	Virgo	Virg
Cep	Cepheus	Ceph	Dra	Draco	Drac	Lyr	Lyra	Lyra	Pyx	Pyxis	Pyxi	Vol	Volans	Voln
Cet	Cetus	Ceti	Equ	Equuleus	Equl	(Malus = Pyxis)	...	Ret	Reticulum	Reti	Vul	Vulpecula	Vulp

* Germany, W.Z. Weltzeit.   + Relative to the Sun.   ‡ From mean and true midnight.

A STAR ATLAS

AND REFERENCE HANDBOOK

I.—NOTES ON STAR NOMENCLATURE, &c.

The Constellations.—The origin of most of the constellation names is lost in antiquity. COMA BERENICES was added to the old list (though not definitely fixed till the time of Tycho Brahé), about 200 B.C.; but no further addition was made till the seventeenth century, when Bayer, Hevelius, and other astronomers, formed many constellations in the hitherto uncharted regions of the southern heavens, and marked off portions of some of the large or ill-defined ancient constellations into new constellations.* Many of these latter, however, were never generally recognised, and are now either obsolete or have had their rather clumsy names abbreviated into more convenient forms. Since the middle of the 18th century, when La Caille added thirteen names in the southern hemisphere, and sub-divided the unwieldy Argo into Carina, Malus (now Pyxis), Puppis, and Vela, no new constellations have been recognised. Originally, constellations had no boundaries, the position of a star in the 'head,' 'foot,' &c., of the figure answering the needs of the time; the first boundaries were drawn by Bode in 1801. For List of Constellations, see last page.

Star Nomenclature.—The star names given on the last but one page have, for the most part, been handed down from classical or early mediæval times, but only a few of them are now in use, a system devised by Bayer in 1603 having been found more convenient, viz., the designation of the bright stars of each constellation by the small letters of the Greek alphabet, α, β, γ, &c., the brightest star being usually made α, the second brightest β—though sometimes, as in Ursa Major, sequence, or position in the constellation figure, was preferred. When the Greek letters were exhausted, the small Roman letters, a, b, c, &c., were employed, and after these the capitals, A, B, &c.—mostly in the Southern constellations. The capitals after Q were not required, so Argelander utilised R, S, T, &c., to denote *variable* stars in each constellation, a convenient index to their peculiarity (see also p. ix).

The fainter stars are most conveniently designated by their numbers in some star catalogue. By universal consent, the numbers of Flamsteed's British Catalogue (published 1725) are adopted for stars to which no Greek letter has been assigned, while for stars not appearing in that catalogue, the numbers of some other catalogue are utilised. The usual method of denoting any lettered or numbered star in a constellation is to give the letter, or Flamsteed number, followed by the genitive case of the Latin name of the constellation: thus α of Canes Venatici is described as α Canum Venaticorum. These genitives are given in the list of constellations on the last page, facing the cover.

Flamsteed catalogued his stars by constellations, numbering them in the order of their 'Right Ascension'—that is, the number of hours and minutes they southed after the southing of a certain zero point among the stars (p. 2). Most modern catalogues are on this convenient basis (ignoring constellations), as the stars follow a regular sequence. But when Right Ascensions are nearly the same, especially if the Declinations (p. 3) differ much, in time 'precession' may change the order: Flamsteed's 20, 21, 22, 23 Herculis, numbered 200 years ago, now south in the order 22, 20, 23, 21.

For convenience of reference, the more important star catalogues are designated by recognised contractions: thus "B.A.C. 2130" is at once known by astronomers to denote the star numbered 2130 in the British Association Star Catalogue of 1845. In most star catalogues a number is assigned to each star included in them, whether it has a Greek or other letter, or not. Thus, *Vega* is α Lyræ, 3 Lyræ (Flamsteed's number), and (constellations ignored) Groombridge 2616. A list of some of the best-known catalogues, and their contractions, is given on p. vii.

Constellation Boundaries.—Bode's boundaries were not treated as standard, and charts and catalogues issued before 1930 may differ as to which of two adjacent constellations a star belongs. Thus Flamsteed numbered in Camelopardus several stars now allocated to Auriga, and by error he sometimes numbered a star in two constellations. Bayer, also, sometimes assigned to the same star a Greek letter in two constellations, ancient astronomers having stated that it belonged to both constellation figures: thus β Tauri = γ Aurigæ, and α Andromedæ = δ Pegasi.

To remedy this inconvenience, in 1930 the International Astronomical Union standardised the boundaries along the Jan. 1, 1875, arcs of Right Ascension and Declination, having regard, as far as possible, to the boundaries of the best star atlases. The work had already been done by Gould on that basis for most of the S. Hemisphere constellations.

* Antinous, added in A.D. 130 by the Emperor Adrian, was long combined with Aquila as 'Aquila et Antinous.' *page 1*

The I.A.U. Boundaries.—These do not change their positions among the stars, thus objects can always be correctly located, though, owing to precession, the arcs of Right Ascension and Declination of to-day no longer follow the boundaries, and are steadily departing from them. After some 12,900 years, however, these arcs will begin to return towards the boundaries, and 12,900 years after this, on completing the 25,800-year precessional period (p.6) will approximate to them, but not exactly coincide.

II. NOTES ON ASTRONOMICAL TERMS.

The Star Sphere, a convenient term used in speaking of the heavenly bodies and their relative positions, derives its name from the appearance of the heavens to an observer : he seems to be at the centre of a vast hollow sphere (half of it unseen, beneath his feet), which revolves round the Earth once each day. The stars seem permanently fixed to the inside surface of this sphere—their vast distances practically nullify their actual rapid motions—and are known as *fixed stars*, in contrast to the 'wandering stars' or *planets*, which move among the others. Rather more than half the star sphere is seen at one time, as refraction adds a strip equal to the breadth of the Moon's disc in the sky.

The Celestial Poles and Equator.—The pivots, as it were, on which the star sphere revolves, are called the *Celestial Poles*; they are directly overhead at the Terrestrial Poles. Half way between them is the great circle of the *Celestial Equator* or *Equinoctial*, which passes directly overhead at every point on the Terrestrial equator.

Culmination : Southing.—A celestial object *culminates* when it reaches its highest point above the observer's horizon. In the N. Terrestrial hemisphere, *souths* is used in the same sense, as culmination is always at the instant when the object is due south of the N. Pole; in the S. Terrestrial hemisphere, objects culminate when due north of the S. Pole.

Rising and Setting of Stars.—At the Terrestrial Equator, the Celestial poles lie on the horizon; all the stars remain above the horizon for half a day, and their rising and setting are at right angles to the horizon. At the Terrestrial poles, on the other hand, the Celestial equator coincides with the horizon, parallel with which the stars move in circles, neither rising nor setting, the other half of the star sphere being never seen.

In intermediate latitudes there is every variety between these extremes, but always some stars never set (and a corresponding area round the opposite Pole never rises), also the paths in the sky cut the horizon obliquely—all in proportion to the observer's nearness to, or remoteness from, the Terrestrial Pole or Equator.

The stars which rise and set always do so at the same points on the horizon—unlike the Sun, Moon, and planets, which rise and set at different points on successive days. In temperate latitudes, especially, those of them nearest the observer's Celestial pole rise far north (S. hemisphere, *south*), and are above the horizon most of the twenty-four hours; as distance from the Celestial pole increases, they rise further and further south (or *north*), and their time above the horizon diminishes, till, for the stars furthest south (or *north*), they set again a very short time after rising. Stars on the Celestial equator rise due E., set due W., and are 12 hrs., above the horizon, all over the Earth—except at the Poles.

Stars rise, 'south' or 'north', and set, at a given hour *only once a year*, always on or about the same date, for they culminate nearly four minutes earlier each day, and make 366¼ revolutions in 365¼ solar days. On one day in the year 'southing,' &c., occurs *twice*, for when a star souths at 12·1 a.m. it will south again at 11·57 p.m. the same day. This occurs with the Superior planets (p. 32) also—Mars, and the asteroids in general, about each second year—their mean daily motions being less than the Earth's. Mars and Venus, however, may not south at all on one day in the year.

The Stars that never set or rise.—Stars never set when their distance from the Celestial pole is less than the latitude of the observer on the earth. Or, stars with Declination (p. 3) greater than the observer's *Co-latitude* his latitude subtracted from 90°) never set ; the corresponding area round the opposite Pole never rises.

The Ecliptic is another important great circle on the star sphere, which intersects the Celestial equator at an angle of 23½° (the *Obliquity of the Ecliptic**), and lies in a plane which passes through the centres of the Sun and the Earth : it represents the yearly path of the Sun's centre on the star sphere, as seen from the Earth, or the Earth's as seen from the Sun : it is shown in Maps 3-14. *The Ecliptic Poles*, the points on the star sphere 90° from the Ecliptic, (about 23½° from the Terrestrial poles), are at R.A. 18h., and 6h., and Dec. 66½° N., and S., respectively.

The Ecliptic and its poles are 'sensibly' (*i.e.*, for ordinary purposes) fixed on the star sphere, but change slightly in centuries. The former also represents (*a*) the central line of the Zodiac (p.3); (*b*) the average path of the Moon, Mercury, and Venus, on the star sphere (pp. 8, 33), but not those of the other major planets—though these are always *near* the Ecliptic, except Pluto.

The Vernal Equinox or **First Point of Aries,** the zero for the celestial measurements corresponding to terrestrial longitude, is the point of intersection on the star sphere, at any moment, of the Celestial Equator and the Ecliptic, at or near the point where the Sun crosses the former from S. to N., about March 21.

This point—the *True* or *Apparent Equinox*, or *The Equinox* of any date—moves westward on the Ecliptic 1/7th second of arc every day, but is nevertheless the most convenient point for the purpose, as the Sun's position in the sky, measured from it, remains practically the same on a given day of the year for thousands of years, by the leap year arrangements of the calendar, though those of the stars slowly change. 'Vernal Equinox,' *when used in connection with measurements*, always means this moving True Equinox, but the *literal* Vernal (Spring, p. 6) equinox is the instant when the Sun's centre actually crosses the Celestial equator.

The Mean Equinox, is the True Equinox corrected for the irregularity (max. ± 1¼ secs.) called nutation in Right Ascension (p. 7). Positions in star charts and catalogues are measured from it, at the time when the Sun's mean longitude is 280°, about Jan. 1 : thus for 1950, the star positions are called 'mean places for 1950·0' — '·0' after a year always indicates the 280° start.

The position of the First Point of Aries is about nine moon-breadths W. of the end of a line drawn first from α Andromedæ to γ Pegasi (which form one side of the 'Square of Pegasus') then extended downwards for the same length.

* Mean, Jan. 1, 1950, 23° 26′ 45″ (annual decrease 0″·47), may vary 9″ from mean.

The Meridian is that great circle on the star sphere which passes through both Celestial poles, and through the zenith of the observer; it always meets the horizon due south and north of the Pole and the observer. *On the meridian, meridian passage, returns to the meridian,* have the same meaning as culmination, or transit (see below).

Transit.—A celestial object *Transits* when it crosses (*a*) the meridian of a place—*Upper Transit* = culmination: or (*b*) any selected line on the star sphere: The term is also used for a meridian or spot crossing the centre of a disc. *Lower Transit,* or *Lower Culmination,* of a 'circumpolar' star which never sets, is at the opposite side of the Pole, twelve sideral hours after upper transit, when the star is nearest the horizon.

Transit also denotes the passing, as a black circular spot, of *Mercury* and *Venus* across the Sun's disc; or of a satellite or its shadow (p. 34) across the disc of its primary. *Ingress* is the entrance on to the disc; *egress,* the departure.

Celestial Positions.—As the star sphere has an Equator and Poles, taking the meridian through the Vernal equinox as zero, the position of any object in the sky can be indicated in the way places on the Earth are located by their latitude N. or S. of the Equator, and their longitude from Greenwich. The corresponding astronomical terms, however, are *Declination* and *Right Ascension,* ancient astronomers having unfortunately (for similarity of nomenclature) used the terms latitude and longitude to denote measurements referred to the Ecliptic, instead of the Celestial equator.

Declination (contracted δ, or *Dec.*) corresponds to terrestial latitude; it is measured in degrees North or South of the Celestial equator. The International Astronomical Union recommend the use of + and − instead of N. and S.

North Polar Distance (contracted *N.P.D.* or *P.D.*), measured in degrees (0° to 180°) from the N. celestial pole, is sometimes used instead of Declination, as it obviates the use of negative signs, and all chance of error with N. and S.

Right Ascension (contracted α, *R.A.,* or *Æ*), corresponds to terrestial longitude, it is measured eastwards, or counter-clockwise, on the Celestial equator from the True equinox, sometimes in degrees (0°-360°), usually in sidereal hrs. (*h.*), minutes (*m.*), seconds (*s.*); 1 h. = 15°, 1° = 4 m. Every observatory has a clock regulated to this sidereal time (p.9); when it shows 0 hrs. the True equinox is on the observatory's meridian.

As the True Equinox culminates daily, it is easy to note how many hours, minutes, and seconds elapse from its culmination to that of any other object; this interval is the *Right Ascension* of the object. Objects that culminate at the same instant as the True Equinox have R.A. 0 hrs.; those culminating 1 hour later, R.A. 1 hr.; those 2 hrs. later, R.A. 2 hrs., and so on up to 24 hrs., the 0 hrs. of a new sidereal day: of course minutes and seconds are also used.

Right Ascension hours, &c., are very slightly shorter than those of ordinary mean time, the 24-hr. sidereal day being only 23 hrs. 56 min. 4 secs. mean time in length, or about four minutes shorter than the mean solar day. (See p. 8).

Hour and Declination Circles.—An *Hour Circle,* or a *Declination Circle,* is the great circle passing through a celestial object and the Celestial poles; the former term is preferable, as the latter is liable to be confused with 'Declination Parallels,' which are not great circles. These terms are also applied to the graduated circles on 'equatorial' telescopes (p. 46); the hour circle is graduated in R.A. hrs. and minutes, and the Declination circle in degrees.

Colures.—*The Equinoctial Colure* is the great circle of R.A. 0 hrs. and 12 hrs.; it passes through the Celestial Poles, the First Point of Aries, and 180° of celestial longitude. *The Solstitial Colure* is the great circle of R.A. 6 hrs. and 18 hrs.; it passes through both the Celestial and Ecliptic Poles, and through the *Solstitial Points**.

The Zodiac (literally 'circle of the animals,' most of the signs represent living creatures) is the belt of the sky 8-9° on each side of the Ecliptic, within which the Sun, Moon, and the planets known to the ancients are found.

Starting yearly at the First Point of Aries, it is divided into the twelve 'Signs of the Zodiac' (see symbols, p. xvi)—each 30° of longitude on the Ecliptic—which, however, do *not* coincide with the constellations of the same name, although they did so some 2300 years ago when the First Point was named, precession having carried them westwards some 30°, or a whole sign.

The Invariable Plane of the Solar System, passing through the System's centre of gravity, forms an unvarying reference plane, as it does not change its position in space owing to mutual planetary perturbations, as the Ecliptic does. Inclined 1° 35′ to the Ecliptic plane, 7° to Sun's equator; longitude of ascending node 106° 35′ (epoch 1850).

The Fundamental Plane, in occultations and eclipses, is that passing through the centre of the Earth at right angles to the line drawn from the star, or the centre of the Sun, through the centre of the Moon.

Alternative Reference Circles.—The Celestial Equator, though the most convenient for finding or recording positions on the star sphere, by R.A. and Dec., is an unsuitable reference circle for many purposes, and other great circles and reference planes are used instead. The position of an object is indicated, with respect to the :—

1.	Celestial Equator …	by its Declination, and Right Ascension, from the Vernal equinox	(p. 3)
2.	Ecliptic, (*a*) from the Earth's centre	„ Geocentric Latitude, and Longitude, „ „ „	(p. 4)
3.	„ (*b*) „ Sun's …	„ Heliocentric „ „ „ „ „ „	(p. 4)
4.	Horizon of the observer … …	„ Altitude, and Azimuth, from the N. or S. point …	„
5.	Meridian … … … …	„ Hour Angle from the meridian, and Declination from the Celest. Eqr. „
6.	Hour Circle or Declination Circle	„ Position Angle, from the North Point … …	„
7.	Galactic Plane, or Milky Way …	„ Galactic Latitude, and Longitude, from node on Celestial equator	(p. 4)
8.	Sun's Equator … … …	„ Heliographic „ „ „ arbitrary zero …	„
9.	Planet's or Moon's Equator …	„ Planetographic „ „ (Seleno-, Zeno-, &c., -graphic, see p. 4)
10.	Limb of the Sun, Moon, or Planet	„ Distance (*a*) from the North Point; (*b*) from the Vertex	(p. 5)

Thus there are several kinds of astronomical latitude and longitude. But unless qualified by an adjective, in astronomy these terms usually mean *Geocentric Latitude and Longitude,* referring objects to the Ecliptic and the Earth's centre.

* In Celestial longitude 90°, 270° (or R.A. 6h., 18h.), and Dec. 23½° N. and S.

Geocentric Positions.—All astronomical observations are necessarily *topocentric*—*i.e.*, made from a point on the Earth's surface—but for simplicity, the figures in Tables are always *geocentric*, that is, calculated as if bodies were observed from the Earth's centre. The reason is that the topocentric values differ with the position of the observer (except for stars—too distant for appreciable change), but are easily obtained for any place from the geocentric values.

Angular and linear distances are in general measured from centre to centre of the bodies concerned, and those calculated as seen from the Sun, or a planet, are also given for the centres (heliocentric, &c., values, see below).

Latitude and Longitude (unqualified by an adjective) refer celestial objects to the Earth's centre and the Ecliptic instead of to the Celestial Equator, and therefore do not correspond to geographical latitude and longitude. They are used for calculations involving angular distance from the Sun, as seen from the Earth, of planets and comets, —phase, opposition, &c.; the same definitions, but referred to the Sun's centre, instead of the Earth's, are termed *heliocentric* latitude and longitude. The Earth's heliocentric longitude is the Sun's geocentric longitude +180°.

The *Longitude* of a celestial object is the angle in degrees (0°-360°) measured eastwards, between the First Point of Aries (♈) and the foot of a perpendicular drawn from the object to the Ecliptic. Similarly, the *Latitude* of a celestial object is its distance in degrees N. or S. of the Ecliptic, measured on an arc at right angles to the Ecliptic.

Longitude and Right Ascension both start from the First Point of Aries, and both are measured eastwards, but the former is measured in degrees along the *Ecliptic*; the latter along the *Celestial Equator*, in hours, &c. (but 1 hour R.A. is exactly 15°, 4 minutes exactly 1°). As the plane of the Ecliptic lies at an angle to that of the Celestial Equator, however, a movement of 1° in longitude does not exactly correspond to 1° (*i.e.*, 1/15th hour, or 4 minutes) in R.A., because (*a*) the direction of measurement is different, and (*b*) the respective degrees may differ in length on the star sphere—as, for instance, where the 'great circle' degrees of the Ecliptic traverse the narrower R.A. degrees measured on the parallel of Dec. 20°. The 'precession' (p. 6) of the First Point of Aries continually changes longitudes, the longitude of the perihelion of each major planet increasing some 2° per century; but latitudes alter very little, as the Ecliptic is almost fixed on the star sphere (p. 2).

Latitude, similarly, differs from Declination. Both are measured on arcs of great circles on the star sphere, but whereas all Declination circles pass through the Celestial poles, all circles of Latitude pass through the Ecliptic poles, 23½° from the Celestial poles. The parallels of latitude, therefore, are always inclined to those of Declination, and a motion of 1° in latitude is never exactly 1° in declination—except along the Solstitial colure (p. 3), which intersects the Ecliptic and the Celestial equator at right angles, and passes through both the Celestial and Ecliptic poles.

Heliographic, Selenographic, and Planetographic latitude and longitude refer objects to the equators of the Sun, Moon, and planets, respectively—the equators with reference to the axis of rotation. They thus exactly correspond to geographical latitude and longitude, and positions are denoted by them in the same way—by latitude N. or S. of the equator in degrees, and by longitude on that equator from a zero meridian. Their chief use is for recording the positions of markings on the surface, such as spots, lunar craters, &c. *Areographic, Zenographic*, and *Saturnigraphic*, are the terms for Mars, Jupiter, and Saturn, respectively.

The zero meridian on the Moon is that of the 'mean centre' of the disc, and longitude is measured E. or W. of it in degrees; for Mars and Jupiter, see the *N.A.* On the Sun, Jupiter, and Saturn, there being no fixed markings, zero meridians can only be arbitrary. The Sun's is based on an assumed unvarying sidereal rotation period of 25·38 days (see p. 26); the longitude is measured (0° to 360°) from left to right looking south, across the non-inverted apparent disc—*i.e.*, in the direction of the Sun's rotation.

Measured on the star sphere, instead of the body's surface, *helio-, seleno-*, &c., *-graphic* latitude and longitude correspond to solar, lunar, &c., Declination and R.A., but *heliocentric, areocentric*, &c., latitude and longitude are usually employed for this sense. They are used for indicating the position of the Sun's equator with reference to the centre of the disc, the amount of lunar libration, openness of Saturn's ring's, &c.—published annually in the *Nautical Almanac*.

Galactic latitude and longitude refer objects to the Galactic Plane (p. 10) or mean plane of the Milky Way— important for problems regarding the distribution of the stars on the star sphere. Galactic latitude is measured in degrees N. or S. of the Galactic Plane; Galactic longitude, along the Galactic plane (0° to 360°), from its intersection with the Celestial equator about R.A. 18h. 40m., and measured in the same direction as R.A. (but see note, p. 10).

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Altitude, Azimuth, Meridian, &c.—These refer the positions of celestial objects to the observer's horizon. The *altitude* of a heavenly body is its vertical angular distance in degrees above the horizon; its *azimuth*, the horizontal angular distance in degrees between the observer's S. or N. point, and the foot of a perpendicular drawn from the object to the horizon. In the N. hemisphere, azimuth is usually measured from south (0°) westwards, *i.e.*, from the *meridian*, already defined as the great circle passing through the Celestial poles and the north and south points of the observer. The *zenith* and *nadir* are the points in the sky directly over the observer's head and below his feet, respectively, *i.e.*, the poles of the horizon; the *prime vertical* is the great circle passing through the zenith and the observer's east and west points, corresponding to the Solstitial colure in R.A. and Declination. The *amplitude* is the arc of the horizon between the E. or W. point, and the foot of the vertical circle passing through the object. (Amplitude of variable stars, see p. 12).

Hour Angle.—The hour angle of a celestial object refers it to the *meridian* of the observer; it is used in calculating an object's altitude or azimuth, the time of its rising or setting, &c., and may be defined as the difference between its Right Ascension and the hour of R.A. on the meridian at the time of an observation, or the angle which the hour-circle passing through the object makes with the meridian—for most purposes expressed in hrs., &c., of sidereal time. It is measured westwards or clockwise from the meridian south of the Pole (S. Hemisphere, N. of the Pole).

Position Angle: North Point.—*The Position Angle* of a planet's axis, or of any line on the star sphere, is its inclination to the hour circle (p. 3) passing through the centre of the object. This circle is the most suitable one for reference, as, unlike the horizon, it is stationary with respect to the stars, and being perpendicular to the horizon at the instant of culmination, can be used for finding the inclination to the horizon at other times (see diagram, p. 39). *The North Point* is the point on the hour-circle nearest the N. Celestial pole, in the field of view.

(*a*). **Double Stars.** The position angle of a double star is the angle which the line joining the components makes with the hour-circle passing through the brighter star of the pair. This angle is measured from the *North Point* (or point on the hour-circle nearest the North Celestial Pole, in the field of view) from 0° to 360°, going round by E., S., and W. (See p. 39).

(*b*) **Sun's or Planet's axis.** The position angle is measured to it from the North Point on the disc. This varies throughout the year; but for the Sun, on the same date it is about the same every year (see the *N.A.*, and diagram on p. 40). The angle is measured from 0° to 360° for the Moon and planets, as in (*a*); but for the Sun, E. (+) or W. (−) of the hour circle.

Limb, Cusps, Vertex.—The *Limb* is the edge of the Sun's, Moon's, or a planet's disc; the *Cusps*, the horns of the crescent (less than half-illumined) Moon, Mercury, or Venus. The *Vertex*, sometimes used for occultations, is the point on the limb furthest above the observer's horizon; distances from the vertex are counted eastwards from 0° to 360°.

Opposition.—Mars, and the outer planets (p. 32), are in *Opposition* (symbol ☍), when 180° of longitude (or 12 hrs. R.A.) away from the Sun on the star sphere: this occurs annually (Jupiter, 1·1 yrs.), but biennially for Mars and most asteroids. They are then on the meridian about midnight, and nearer the Earth than when not in opposition.

An opposition is 'favourable' when the Earth and the planet are near the point where their orbits most closely approach, and as this point is always about the same longitude, favourable oppositions *always take place about the same date in the year* (given on pp. 32 to 34), and the favourableness or otherwise of any opposition can always be judged by its nearness to, or remoteness from, that date; the least favourable are six months later.

Conjunction: Syzygy.—A celestial object is in *conjunction* (symbol ☌) with another celestial body when their longitudes are the same, but the term may also denote equality in Right Ascension—as in *N.A.* 'Phenomena,' for some objects. Mercury and Venus are in *Inferior Conjunction* with the Sun, if the conjunction occurs when they are on the side of the Sun nearest the Earth: in *Superior Conjunction* if they are on the far side of the Sun, with the Sun between the planet and the Earth. The Moon is in *Syzygy* when in conjunction or opposition, *i.e.*, when New or Full.

Appulse.—An appulse is the near approach of one celestial body to another: the term is also used for approaching culmination, conjunction, &c.; as, the appulse of a star to the meridian, of the Moon to the Earth's shadow.

Orbital Motions.—The orbital motion of a planet or comet round the Sun, or of a satellite round its primary, is *Direct* when from W. to E.; *Retrograde*, when from E. to W.: similarly the seeming motions of the planets among the stars, as seen from the Earth. A planet is *Stationary* when its movement is reversing to the opposite direction.

A planet or comet is in *Perihelion* (π) when at the point in its orbit nearest the Sun; in *Aphelion*, when at the point most distant; in *Quadrature* (□), when 90° in longitude from the Sun. The Moon and the planets are in *Perigee* when at the point in their orbits nearest the Earth; in *Apogee*, when at the point most distant. *Pericentre* and *Apocentre* are the corresponding general terms for a satellite with respect to its primary: for Mars, Jupiter, Saturn, *Perimartium*, *Perijove*, and *Perisaturnium*, are used. A planet's *Elongation* from the Sun is the angular distance in degrees as seen from the Earth: the *Greatest Elongation* of Mercury and Venus is when that angular distance reaches a maximum—not necessarily the very greatest. A comet in *Recession* is moving away from the Sun, after perihelion.

Elliptical Orbits.—The *Major Axis* (symbol for semi-major axis, *a*) is the greatest length, usually expressed in Astron. Units; midway in it is the *Centre* of the ellipse. The *Minor Axis* (semi-minor, *b*) is the line drawn through the centre at right angles, the greatest breadth: *the Focus*—occupied by the Primary (p. 7)—one of two points, equidistant from the centre, such that the sum of their distances from the foci to any point on the orbit is constant, and equal to the major axis.

The Eccentricity (e) is the ratio, to the semi-major axis, of the focus-to-centre distance; *the Radius Vector (r)*, the line joining the centre of a planet, comet, or satellite, to that of its primary, usually given in A.Us. *The Apsides* (plural of apsis) are the extremities of the major axis—the points of perihelion, aphelion, perigee, &c.; the *Line of Apsides*, that axis extended indefinitely.

The Nodes are the points where a planet's or comet's orbit intersects the Ecliptic on the star sphere—*i.e.*, when the object is in the Ecliptic plane: where the object crosses from S. to N. is the *Ascending node* (☊), from N. to S. the *Descending node* (☋).

The Anomaly [*true*] (*v*) is the actual perihelion-focus-planet angle, measured in the direction of the planet's motion; the *Mean Anomaly (M)*, that angle calculated for uniform, not actual, motion: the *Eccentric Anomaly* (μ) is derived from it, $M = μ − e \sin μ$.

The Elements of an Object are seven factors required to determine (*a*) Position in space of its orbit—1, the semi-major axis: 2, the eccentricity: 3, the inclination to the Ecliptic: 4, the longitude of the ascending node: 5, the longitude of the perihelion: (*b*) Position of the object at any time—6, the orbital period; 7, epoch (position at a known date); or, time of perihelion passage.

These are the *Heliocentric or Fixed Elements*—the object's relation to its primary, the Sun, ignoring other planets. The *Barycentric Elements* are those referred to the *Barycentre*, or centre of *mass* of the Solar System, instead of the Sun, which give a better average orbit—though the heliocentric one corrected for *perturbations* (disturbances) by the other planets is more accurate.

The Osculating Orbit is that which a planet or comet would pursue if, at some specified instant, the *Epoch of Osculation*, all the planets should cease to attract that body, and leave it free to move under the attraction of the Sun alone.

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* In an elliptical orbit, the node-perihelion-node angle is always less, in degrees, than node-aphelion-node, but the difference is trifling if the eccentricity is small, as in the principal planets. Also a planet attains its maximum heliocentric latitude, above the plane of the Ecliptic, halfway between the nodes—at about 90° longitude, for the principal planets, which have nearly-circular orbits.

Planetary Periods.—The *Sidereal Period* of a planet, its true period of revolution round the Sun, is the time it takes to make a complete circuit round the star sphere, from star to star again, as seen from the Sun, not the Earth.

The *Synodic* or *Apparent Period* of a planet is the interval *as seen from the Earth's centre*, between successive oppositions (or conjunctions) with the Sun; or, for a satellite, between successive similar elongations or conjunctions with its primary. The *Anomalistic Period* is the interval from any point in a planet's orbit to the same point again —for instance between successive returns to perihelion or to aphelion; this period, and also that of successive returns to the same node, is practically the same as the planet's sidereal period.

The Synodic period determines the dates of opposition, conjunction, &c.; the Sidereal period, those of the opening and closing of Saturn's rings, also of the recurrence of a planet's greatest N. or S. latitude—important for observing Mercury.

Secular Acceleration.—An apparent shortening of the periods of Sun, Moon, and planets, as compared with those calculated on the basis of uniform motion—a shortening so minute as to be only detectable in 'secular' periods, *i.e.*, those of the order of a century; it is expressed by the number of seconds of arc per century the object is ahead of the uniform-motion position. It is simplest to suppose that the periods do not change, but that our day, the unit of measurement, is slowly lengthening (partly through tidal friction) by some 1/1000th of a second per century, on the average, so that after a century the number of days in a year is a fraction less than before. 6″ of the Moon's acceleration, however, is due to other causes than the lengthening day.

Secular acceleration of the Moon, about 10″ per century (1337 sidereal months); *of the Sun*, about 1″·5 per century.

Rotation Periods.—The *Sidereal* rotation period of the Sun, or of a planet or satellite, its true period of axial rotation, is the interval between a star's successive returns to the same meridian on the Sun's or planet's surface.

The *Synodic* or *Apparent* rotation period of the Sun, or of a planet, is the interval, as seen from the Earth's centre, between successive returns of a meridian on its surface to the centre of the disc. The apparent rotation periods of the Superior planets merely vary to and fro a very little on each side of the sidereal rotation periods.

The Sun and the planets—Uranus excepted—have actually the same 'direct' rotation as the Earth (from W. to E. looking south), but to us are seen revolving from E. to W., because the hemisphere we see faces in the opposite direction from our hemisphere.

The Equinoxes and Solstices.—*The Vernal and Autumnal Equinoxes* are two days in the year on which, everywhere on the Earth, day and night are equal, whence the name. The instant when the Sun crosses the Celestial equator into the N. Celestial hemisphere, on March 19-22, determines the Vernal or Spring equinox (also the solar year, p. 8); this instant may be distinguished as the *literal* Vernal equinox, in contrast to the moving conventional Vernal equinox used for R.A. The Autumnal equinox is on or about Sept. 23, when he recrosses into the S. Celestial hemisphere.

The Solstices are on the longest and shortest days of the year, on or about June 21 and Dec. 22, when the Sun attains his greatest angular distance N. or S. of the Celestial Equator,[*] and 'stands' for an instant before turning back; the Equinoxes and Solstices always keep to these dates, by the Leap year arrangements of the calendar. In the South terrestial hemisphere the seasons are reversed, Sept. 23 being the spring equinox, Dec. 22 the summer solstice.

Precession of the Equinoxes is the annual occurrence of the (literal) vernal equinox, about Mar. 21st, nearly 20½ minutes (1/25,800th year) before the Earth has made a *complete* orbital revolution round the Sun, so that each year, at that instant, he crosses the Celestial equator at a slightly different point. 25,800 years will elapse before he again crosses at that point. As the result of precession, every star—except those less than 23½° from the Ecliptic poles —passes through every hour of R.A. from 0h. to 24h., once every 25,800 years; also the Declinations, every 12,900 years, swing to and fro 47° (23½° × 2), greatly changing the stars visible at a given place, or season.

Precession is due to a continuous minute tilting of the Earth's axis by the Sun and Moon, which causes the Celestial poles and equator (always overhead at those of the Earth) to change their places continuously among the stars in harmony, so that each successive moment the Celestial equator intersects the Ecliptic at a slightly different point (in the opposite direction to the Earth's orbital motion) of the one it would occupy if left undisturbed. Thus precession is continuous, not a yearly jump.

The tilting is the result of the bulge at the Earth's equator, inclined considerably to the plane of her orbit round the Sun, and also to that of the Moon. Half of the bulge is above and half below the plane of the Earth's orbit, part of it considerably, and the Sun's and Moon's pull on the elevated (or depressed) portion nearest them is stronger than their pull on the more distant depressed (or elevated) portion opposite. This tends to tilt the Earth's axis towards the attracting body, and, by the gyroscopic law applicable to the rapidly-rotating Earth, causes the Earth's axis (which would otherwise always point to the same position on the star sphere) and the Celestial poles to rotate round the poles of her orbit (*i.e.*, those of the Ecliptic) in circles 23½° distant from them, and in a period of 25,800 years, displacing the Vernal Equinox in the opposite direction to her orbital motion.

The Amount of Precession.—Every day the Celestial equator intersects the Ecliptic at a point about 1/7th of a second of arc W. of the position the day before at the same hour, so that R.A. is measured from a slightly different point on the star sphere each day, and each March 19-22, the *literal* Vernal equinox is 50″·26 W. of its position a year before—about 3 seconds of R.A., or 1/37 of the angular breadth of the Moon, or 1° in 71·62 years, or 1°·396 per century. Thus the First Point of Aries—which some 2200 years ago was in the constellation of Aries—is now 30° to the west, in the constellation of Pisces. Star charts sooner or later cease to give reasonably accurate positions, owing to this change in the zero-point on the Ecliptic, amounting to a whole degree, or two Moon-breadths, in about 72 years.

In Star Catalogues the precession in R.A. and Declination represents the co-ordinates of the total annual linear precessional motion of each star along the Ecliptic. Near the Celestial poles, the figures make it seem very great, but as regards actual change on the star sphere they are misleading. Among the closely-crowded nearly-converged hour-circles of R.A. near the poles, a movement of many seconds in R.A., as measured along the very small Declination parallels, is only a few seconds when converted into Equatorial great-circle measure. In converting a star position for precession, *add like signs, subtract unlike signs*

* At the Solstitial Points, p. 3.

Nutation.—The precessional path traced on the star sphere by the Celestial Pole is a wavy line varying slightly from a true circle. This irregularity is called *Nutation*, being, as it were, a 'nodding' of the Celestial poles to and from from the Ecliptic Poles, and though minute—about 9″ on each side of the mean, or 18″ in 18⅔ years—perceptibly modifies the precessional displacement in R.A. and Declination. The Earth's axis passes the mean position about 2800 times in the 25,800-year period. Nutation is due to the Moon's being sometimes above and sometimes below the Ecliptic, and so not always pulling on the Earth's equatorial protuberance in the same direction as the Sun.

The above figures for nutation give the *Nutation in Obliquity*—the total motion of the Celestial Poles to and fro from the Ecliptic poles. *Nutation in R.A.* is its co-ordinate measured along the Celestial equator ; and *Nutation in Longitude*, or the *Equation of the Equinoxes*, its co-ordinate measured along the Ecliptic.

Variation of Latitude.—Star Declinations show minute irregular cyclic changes up to 0″·04, due to the Earth's Poles wandering round her mean rotation-axis counter-clockwise—the combined result of periods arising from (*a*) that axis differing from her axis of figure (432 dys.); (*b*) meteorological changes (1 yr.): max. departure from mean, 60 ft.

Primary, Satellite.—Two (or more) celestial bodies which revolve round a common centre of gravity are *physically connected*: the larger is the *Primary* (the Sun, for planets and comets), the smaller, the *Satellite*—or for stars the *Companion*, which implies visual proximity, but not necessarily physical connection. Stars with motions similar in amount and direction on the star sphere (Moving Clusters, p. 11), are also taken as being physically connected.

Phase denotes (*a*) the extent to which the disc of the Moon or a planet, as seen from the Earth, is illumined or not illumined by the Sun—in the latter case, its *Dark Phase*, or *Defect of Illumination*. (*b*) Appearance or configuration, as in the *N.A.* 'Phases of the eclipses of Jupiter's satellites'; *Aspect* is also used in this sense. (*c*) The stage of progress towards maximum or minimum of a variable star, + denoting the No. of days towards the former, – towards the latter. (*d*) In any periodic phenomenon, the fraction of its period which has elapsed since the last occurrence of a given aspect.

Dark Phase is greatest in the Superior planets when they are in *Quadrature* (□), *i.e.*, 90° longitude (or 6 h. R.A.). from the Sun, and therefore on the meridian about 6 a.m. or 6 p.m. As phase decreases with increasing distance from the Earth, it is only observable on Mars, which becomes *gibbous*—i.e., not quite a full disc—and on Jupiter, to the extent of a slight shade along the limb furthest from the Sun. On the other outer planets it is wholly unmeasurable.

Albedo.—When sunlight falls on a planet, part is absorbed, the rest reflected: the *Albedo* of the planet is the ratio, to the total sunlight received, of the light it reflects in *all* directions: this cannot be determined from full phase alone, and different formulæ give rather different results in some cases, see the Table on p. viii.

Refraction.—All observations of position have to be corrected for atmospheric refraction, which raises a celestial object higher in the sky than its true position, by fully ½° at the horizon, decreasing to 0° at the zenith (Table p. x).

Aberration.—The velocity of light is not infinite compared with the Earth's orbital velocity, and the two velocities combined results in a small variable displacement (max. 20″·47 on each side) of celestial objects from their true positions; the Earth's rotation causes a lesser aberration. At the end of a sidereal year, however, a fixed star returns to its original place, so far as aberration is concerned.

Apparent : True.—In astronomy 'things are not what they seem,' in literal fact. Movements actually seen, and positions read off, by the observer, are in general not the real movements or positions, owing to refraction, aberration, Earth's orbital motion, &c., and are therefore called *Apparent* or observed movements or positions—Apparent Time, Noon, R.A., motion, &c. The *True* (real) values are 'reduced' from the apparent ones by eliminating the effects of refraction, and other factors modifying the actual values, but sometimes 'True' = 'Apparent,' as in True Time, True Equinox.

Epoch.—The date for which an astronomical catalogue, chart, or position, &c., has been calculated, as, sooner or later, precession, proper motion, &c., perceptibly change the positions given, and comparison at future epochs would be of little use without this date. The usual date is Jan. 1st of the year; that of 1950 is a standard one.

Ephemeris (plural Ephemerides). Any Table of calculated positions, &c., in connection with a celestial object. The *American Ephemeris* corresponds to the British *Nautical Almanac*, and has some Tables not given in the latter.

Equation.—A small correction on the figures actually observed, to eliminate instrumental, ocular, and other imperfections, grouped together as *Systematic Errors*—i.e., errors that always recur when the observations are repeated under the same conditions, and with the same instruments (*Accidental Errors* are those that do not recur, as from abnormal refraction, &c.). Also a similar correction for orbital irregularity, as in the *Equation of Time*, and *of the Equinoxes* (see above). For the errors of the eye in observing, see an interesting paper in the *J.B.A.A.*, vol. 39, p. 4.

The Personal Equation of the observer affects observations of every kind, and for refined work has to be found by experiment ; the transit records of one observer are regularly late or early compared with those of another observer.

Colour and Magnitude Equation, see p. 17. Transits of the same star recorded in the hours after sunset and before sunrise, respectively, also seem to require an equation, a difference of some 0·06 second having been noted.

Fundamental or Clock Stars, are stars the positions, &c., of which have been measured with the utmost care, and which are used as reference points for finding the R.A. of other stars with less labour. The positions of these stars for each day is given in the *N.A.*; they are called 'clock stars' because they are used for regulating the clocks.

Dependencies : a short, and accurate method of measuring positions on star photographs from the *Dependence Centre*—an imaginary point, close to the image of an asteroid or planet, the position of which can be exactly calculated.

A Day is (*a*) the axial rotation-period of the Sun, Moon, or a planet; (*b*) the interval between successive returns of a celestial body to an observer's meridian. With respect to the Sun, or a star, three 'days' are used in astronomy:—

1. *The ordinary Solar Day* of 24 hours—strictly speaking the slightly irregular interval between successive transits of the real Sun, but in practice taken as the unvarying interval between those of an imaginary 'Mean Sun,' adjusted to the *average* solar day. The true solar day is variable to the extent of 51 seconds between the extremes, being 30 seconds over the mean solar day about Dec. 22, and 21 seconds under the mean about Sept. 17. A new day or date on the Earth begins on the *Date Line*—the meridian 180° E. of Greenwich, with deviations for geographical, &c., reasons. *Julian Day, p. 9.*
   The Longest and Shortest Days are at the Solstices, but owing to the difference between Sundial and Mean time (local), and to changes in it resulting from the varying hour of sunset or sunrise in different latitudes, the dates of earliest rising and setting vary from the actual solstices with the latitude. There are two earliests and latests in low latitudes (see p. xii).

2. *The Sidereal Day* (conventional) of 24 sidereal or R.A. hours, the interval between successive transits, *not* of a star but of the ever-moving True Equinox (23 h. 56 m. 4·0905 secs. mean time) ; it is really the *equinoctial* sidereal day, used in preference to (3) because the Sun's R.A.—being always 0' about March 21—is always about the same on a given day of the year.

3. *The True Sidereal Day*, the interval between successive transits of a star (23 h. 56 m. 4·0906 secs. mean time), is the exact period of the Earth's axial rotation. Each year it falls behind (2) by 3·3 secs. mean time, or exactly 1 day in 25,800 years. As this is nearly 1 hour per 1000 years, the stars familiar to us now as winter, spring, &c, stars will in some 6000 years be those of autumn, winter, &c. The true sidereal day is (irregularly) lengthening about 1/1000th second per century, on the average ; in harmony, therefore, the sidereal year, expressed in days, *shortens* about 1/3rd second per century.

A Lunar Day, the interval between successive meridian transits of the Moon, varies from 24 h. 38 m. to 25 h. 6 m., and averages 24 hrs. 51 m.; it determines the tide-interval from high water to high water, which is *half* a lunar day.

Our *Mean Time* (Mean Solar Time) is based on the mean solar day; *True*, or *Apparent Solar Time*, or sundial time—which varies slightly from day to day—on the Sun's actual southings ; *Sidereal Time*, on the sidereal day.

The Year.—The *Solar, Equinoctial*, or *Tropical Year* (365·2422 solar or 366·2422 sidereal dys) in which the seasons recur, is determined by successive returns of the Sun to the same equinox; or to the same 'tropic' or 'solstitial point,' the point on the star sphere where he attains his greatest distance N. or S. of the Celestial equator, on mid-summer or mid-winter days : 'tropic' also denotes the Declination parallels on the star sphere passing through the solstitial points.

The *Sidereal Year* (365·2564 days) is the interval between successive conjunctions of the Earth with a star, as seen from the Sun ; it is the true period of the Earth's orbital revolution round the Sun. (Solar year is 20½ min. less).

The *Anomalistic Year* (365·2596 days) is the mean interval between the Earth's returns to perihelion about Jan. 2 ; as it varies a day or two on each side of the mean, perihelion may occur twice in a calendar year, or not at all.

The *Julian Year*, used in our calendar, has exactly 365·25 (365¼) days: the fraction is adjusted by having *Calendar Years* of 365 or 366 days, the latter in every fourth year divisible by 4 (leap yr.). All years have been Julian since the Julian year was instituted in 45 B.C., except (*a*) 1582, which by the Gregorian revision of that year had only 355 days (Britain and its American colonies substituted 1752, which had only 355 days instead of 366), and (*b*) 1700, 1800, 1900, restricted to 365 days by the new Gregorian rule omitting leap year in century years not divisible by 400.

The *Lunar Year* (354·3670 days) of twelve lunations, used in the Mahommedan calendar, has twelve months of 29 or 30 days each, based on the *phasis*, or first observation, of each New Moon ; it may have 354 or 355 days.

Bessel's Fictitious Year, used in the *N.A.* Mean Star Places, begins at the instant when the Sun's apparent mean longitude is 280°, on Dec. 31st civil date (in the *N.A.* 'Jan. 0,' to which it corresponds), or on Jan. 1st.

The *Eclipse Year* (346·6200 days), the interval between successive returns of the Sun to the same node of the Moon's orbit, is the period of possible recurrence of both solar and lunar eclipses, which can only take place when these bodies are within a small distance from the node. 19 eclipse years are 6585·78 days, almost exactly the same as the ancient 'Saros' cycle of 6585·32 days, (18·03 yrs.), the period after which the same eclipses occur regularly for centuries.

A Planet's Year denotes the period in which it completes one orbital revolution round the Sun.

Lunar Months.—The *Synodic Month* or *Lunation* (mean, 29·53059 days), the period from New Moon to New Moon, or between similar phases, varies between 29¼ and 29¾ days. New Moons recur on the same day of the year every 19 years (subject to leap-year disturbances)—the ancient *Metonic Cycle* of 235 lunations, or 6940 days. But four cycles were found to displace recurrence a whole day, as 235 lunations only amounted to 6939¾ days, so the more accurate *Callippic Cycle* of 6939¾ days × 4 was framed, which adjusted the error on the same principle as leap year.

The Anomalistic Month, from perigee to perigee, 27·55455 days on the average, is the period of the Moon's changes in angular diameter and luminosity, as seen from the Earth; it varies a day or two on each side of the mean.

The Sidereal Month (mean, 27·32166 days), the period in which the Moon circuits the star sphere from transit at the same instant as a star back to transit at the same time with it again, is also the short-term period (p. 38) in which an occultation may recur, or in which the Moon's close proximity will again hinder the observation of a star.

The Nodical Month, or *Draconitic Period* (mean, 27·212220 days), from a node back to the same node again, is also the period in which the Moon again attains her greatest distance N. or S. of the Ecliptic: it varies from about 27 to 27½ days. As the Moon's nodes travel westwards along the Ecliptic about 1½° per month, her path sweeps completely round the star sphere in about 18¼ years: the Ecliptic therefore represents the Moon's *average* path on the star sphere.

The Tropical Month (mean, 27·32158 days), the Moon's period from conjunction with the True Equinox back to conjunction again with that Equinox, is the period after which the Moon has again the same long'tude.

Sidereal Time, used for measuring R.A., is the interval, in sidereal hours, minutes, and seconds, since the preceding meridian passage, at a given place, not of a star but of the True Equinox or First Point of Aries ; each sidereal hour is 1/24th of the average interval (see below), and 9·83 secs. mean time shorter than the mean solar hour, making the sidereal day 3m. 55·91s. (mean time) shorter than the mean solar day. Each observatory has a sidereal clock keeping this time, to give the hour of R.A. on the meridian at any time (Table p. xiv); at 0 hrs. by the clock, the True Equinox is on the observatory's meridian. As that Equinox is not directly observable on the meridian, the clock is regulated by observing transits of 'clock' stars (p. 7) of known position, given in the *N.A.*

Sidereal Time is thus a *local* sidereal time, measured from, and keeping step with, the True Equinox of date, but differing from the sidereal time of every other observatory not on the same meridian. Being measured by a clock it is a uniform time, but it is not *Actual Sidereal Time*, the interval between successive transits of the True Equinox being slightly irregular ; the difference from the clock time, however, is too small to cause practical inconvenience.

Uniform or Mean Sidereal Time has the same relation to ordinary sidereal time as Mean Time has to True Time. It is measured from the *Mean* equinox of date, instead of the True equinox ; the difference never exceeds ± 1·2 secs.

Mean Time, shown by ordinary clocks, is the interval since the preceding 'mean midnight,' or instant when, during the night, an ordinary clock, correctly regulated to the average length of the mean solar day from noon to noon, shows 12 hrs., or a 24-hour clock shows 24 hrs. *Mean Noon* is the instant when mean time clocks indicate XII, at mid-day. Each country has its own meridian for 0 hrs., (see below 'Standard Time'). *Local Mean Time*, see below.

Apparent Time or *True Time* (solar), is *Sundial* or *Local Time*, based on the observed interval (varies slightly, p. 8) between two successive transits of the Sun's centre at a given place. These differences, by accumulation, may mount up to ± 15-16 minutes from the mean interval, thus to obtain the true Local *Mean* Time, a correction called the *Equation of Time* has to be added to the True Time, or subtracted : this is given in almanacs, sometimes on the sundial (*Table*, p. xii). The Sun and clock agree, however, on or about April 15, June 14, Sept. 1, and Dec. 25.

Astronomical and Civil (Mean) Time.—Both begin at midnight, the former starting at 0 hrs., the latter at 12 a.m., and are the same till noon—in Civil Time 12 p.m., when the hours begin again with 'p.m.', till midnight. But Astronomical Time, to avoid confusion with a.m. and p.m., continues 13 hrs., 14 hrs., &c., to 24 hrs. or 0 hrs., midnight.

Interval between two Phenomena.—Till Dec. 31, 1924, the astronomical day ran from noon to noon, so that its last twelve hours were in the following civil day. As this caused confusion, on Jan. 1, 1925, the astronomical day beginning was put back twelve hours, to coincide with the civil day. Hence in finding intervals, one before and the other after midnight Dec. 31, 1924, to obtain the true interval, *12 hours must be deducted* from the apparent interval arrived at from the *N.A.* dates and hours. The best way to find long intervals is to convert the dates into days of the Julian Period (see below) by the *N.A.* Tables.

Universal Time (U.T., T.U.), [Britain, *Greenwich Mean Time (G.M.T.)* ; Germany, *Weltzeit*, World-time, *W.Z.*], denotes the Mean Time for the meridian of Greenwich, starting at midnight for both Civil and Astronomical Time. Outside Britain, *Greenwich Civil Time (G.C.T.)* was often used for this time till the I.A.U. adopted *U.T.*, 1935.

Noon to noon astronomical time, when required, is designated *G.M.A.T.*—Greenwich Mean Astronomical Time.

Standard Time is an international arrangement for facilitating inter-communication, whereby (*a*) Greenwich is taken as the universal zero of longitude and time, and (*b*) the official mean time of each country or large district differs from Greenwich time by an exact multiple of half an hour. For the various Standard Times see almanacs.

Local Mean Time, required for finding the clock time of sunrise, southing of the Sun, &c., is the true *mean* time of the meridian of a place. On the standard meridian, at a given hour, the local time is slow compared with that of places to the E., where the day begins sooner, but fast compared with that of places to the W.; hence to obtain local mean time, add to, or subtract from, the standard mean time, 4 minutes for each degree the place is E. or W., respectively, of the standard meridian. Thus if using, in other places, the Sunrise and Sunset Tables calculated for the local time of the standard meridian (see the *N.A.*), the longitude correction must be *subtracted* for E., *added* for W., as the phenomena take place earlier and later, respectively, than at the standard meridian.

Light-Time, the time taken by light to travel from a celestial body to the Earth at a given moment, has to be allowed for when computing true rotation periods, &c. For the Sun, at mean distance it is 498·58 secs. (8·31 min.) ; the maximum is about 8·4m., the minimum, 8·2m. The observed maxima and minima times of variable stars require a + or − light-time correction for the Earth's position, as periods are stated for the Earth at mean distance.

The Julian Period (J.P.), used to calculate the exact interval between dates at long intervals apart, starts on Jan. 1, 4713 B.C., at noon. The *Julian Day*, or *Julian Date* (contracted J.D.) is the number of days that have elapsed since the beginning of the Julian Period ; a Table in the *N.A.* gives the Julian Day corresponding to Jan. 1 of each fourth year from 1 B.C., which the Table calls 'A.D. 0'. In ordinary chronology, A.D. 1 is the year following 1 B.C., and as there is no zero year, when B.C. and A.D. years are added, the resulting period is one year too great ; or, if subtracted, one year too little. Calling 1 B.C., 'A.D. 0 (astronomical)'; 2 B.C., '1 B.C. (astron.),' and so on, gets over the difficulty.

For astronomical purposes, decimals of a day are employed with the Julian Day, instead of hours and minutes, as addition and subtraction are easier ; thus Jan. 1, 1926, 9 p.m., astronomical time, is stated as J.D. 2,424,517·375, reckoned from noon. But the Julian Period being still reckoned from noon, not midnight, note that all astronomical hours less than 12 h. 0 m. (or ·5 day), still belong to the Julian Day *preceding* the civil date. Thus Jan. 1, 1926, 9 a.m., astronomical time, is J.D. 2,424,516·875, *i.e.*, Dec. 31 1925, 21 hrs., of the Julian Period. (Decimals of a day, p. xv).

* Sometimes J.A.D.—Julian Astronomical Day.

D

The Galactic System.—Though sagacious conjectures as to the structure of the Universe had been previously made, nothing was known from observation till 1785, when Sir W. Herschel concluded, from the distribution of the stars, and the relative magnitudes of the brightest and faintest stars seen in his 18¾-inch telescope, that the Galaxy was in the form of a thin lens-shaped disc, slit at one end lengthways where the Milky Way branches. Its length he stated as about six times its greatest breadth, and he believed that the Sun was near its centre, but as nothing was known of the distances of even the brightest and therefore presumably the nearest stars (except that they were greater than that corresponding to 1″ annual parallax), he could only state the dimensions in what he called *Siriometers*, the (unknown) distance of *Sirius* or an average first magnitude star; this could be converted into actual dimensions when the parallax became known. Expressed in modern units, Herschel's dimensions are 5950 light-years across, 1085 through.

When, however, the distances of the Magellanic Clouds (p. 13 and extra-galactic Nebulæ became known, our Universe was found to have definite limits, and to be merely an 'island universe'—one out of millions of similar systems separated by distances of millions of light-years. Our Galactic System—containing some 30-100,000 million stars, and perhaps larger than the others—seems to be in the form of a lens-shaped disc some 100,000 light-years in its greatest length, and some 6000-10,000 in its greatest thickness, with a spheroidal centre perhaps 15,000 light-years in diameter.[*] The stars are greatly condensed towards the galactic plane.

The Galaxy is in rotation round *The Galactic Centre*, some 30,000 light-years from the Sun, in the dense star-clouds near the junction of Sagittarius, Scorpius, and Ophiuchus, about galactic lat. 0° and longit. 325-330° (Map 12)—there is no evidence for a central Sun, once thought probable—and the rotation periods of its members decrease with distance from the centre, those near the Sun being about 225 million years, at a speed of some 275 km/secs. (171 m/secs.). *The Rotational Term* of the Galaxy is the rotational velocity round the Galactic centre corresponding to a given distance from that centre (but may be used of any term arising from galactic rotation): being proportional to the distance, it can be found by measuring the intensity of interstellar lines, (p. 23; see *Pub. D.A.O.*, vol. 5, 1933).

Novæ, Wolf-Rayet stars, Cepheid variables, Planetary nebulæ, the Gaseous nebulæ, stars of Types B and N, and eclipsing binaries, show an unusually strong preference for the Milky Way and its neighbourhood, while the Globular clusters and Extra-galactic nebulæ seem to avoid it—now believed to be largely the result of the opaque matter being distributed more thickly in the Galactic Plane, similar to what is seen in spiral nebulæ viewed edgeways.

It is probable that our System of stars, globular and open clusters, gaseous nebulæ, and dust clouds, is a spiral nebula, something like the Great Andromeda Nebula, with local condensations in its arms, in one of which the Sun is situated a little above the plane of the Galaxy—the Galaxy being a 'small circle' of 88° (Struve).

Metagalactic Space is space outside the limits of the Galaxy; *Anagalactic Space*, that within its limits.

Interstellar Matter.—The space intervening between the members of our System is not empty, as was once thought, but is occupied by matter of exceeding tenuity—which has been computed as being of the order of 3 ounces per 1000 cubic miles—rotating on the whole with the general System, and revealing its presence by 'interstellar lines' (p. 23), and—near the Galactic plane, where it is denser, though elsewhere mostly evenly distributed—by light-absorption, which reddens the stars (p. 22). There are also vast opaque clouds, probably minute dust particles, to which the irregular breadth and outline, and the rifts and gaps, of the Milky Way, also the dark patches elsewhere, are partly due.

The Galactic Plane, passing through the central line or equator of the Galaxy (Galactic lat. 0°), is of fundamental importance in stellar study, owing to the peculiar distribution of various classes of objects with respect to it (see above). This plane is completely defined by the position of its N. pole, but authorities vary (see below). The I.A.U. (1932) recommend as the Standard System for statistical purposes, R.A. 190°, Dec. + 28°, 1900 (Ohlsson, practically Argelander's). For *Selected Areas*, Harvard uses Gould's value; for Galactic Charts 17-18, the Standard is used.

The Galactic Equator.—Authorities differ somewhat as to its course, as is not unnatural owing to the very irregular outline of the Milky Way: reference to the rough outline in the star maps will show that in several places the Galactic equator comes near the edge of the visible Milky Way, the observed central line of which averages about 1° S. of the actual equator. Newcomb's position for its N. pole (see below) includes the 'branch.'

The North Galactic Pole is about 1°W. of 30 Comæ Ber. (Map 9), where the extra-galactic Nebulæ cluster thickly; the Table gives various estimates (dates not epochs): the *S. Galactic Pole* is near nebula H. VI 20 Sculptoris (20⁶, Map 4).

Authority.	R.A. = h. m.	Dec. N.	Authority.	R.A. = h. m.	Dec. N.	Authority.	R.A. = h. m.	Dec. N.
Herschel,	187¼° (12 29)	31° 30′	Newcomb (1904)	191° (12 44)	26° 48′	...	...	...
Argelander,	190° (12 40)	28° 5′	Hertzsprung (1912)	190¾° (12 43)	27° 12′	...	...	...
Marth (1872)	190° (12 40)	30° 0′	Walkey (1914)	191¾° (12 47)	27° 0′	...	...	...
Gould (*U.A.*, 1875)	190¼° (12 41)	27° 21′	Graff (1920)	192¼° (12 49)	26° 48′	...	...	...

Galactic Longitude.—The usual zero is the intersection of the Galactic Equator with the Celestial Equator about R.A. 18h. 40m. If, however, the galactic meridian passing through a star with almost no proper motion, as α Cygni, were adopted instead, as has been proposed, the precession of the equinoxes would not affect the galactic co-ordinates as it does at present—obviously a great advantage, unless epoch 1900, say, is kept as a permanent zero. If the galactic longitude of α Cygni is made 0° (I.A.U., 1925), about 51° must be deducted from the galactic longitudes measured from the node of the Galaxy on the 1900 Celestial equator. Charts 17, 18 of this Atlas give both Galactic and ordinary co-ordinates.

F-2 (4/5)   [*] Plaskett, Halley Lecture, 1935.

The Milky Way or Galaxy, composed of millions of minute stars, observationally forms a great ring extending right round the star sphere, inclined about 61° to the Ecliptic plane, and slit lengthways at one part. It is brightest in Cygnus and Aquila (N. Hemisphere), in Scorpius and Sagittarius (S. Hemisphere), and faintest in Monoceros.

Between Cygnus and Scorpius the Galaxy forms two narrow parallel bands for some 110°, then it is very much broken up and complex for a considerable distance, but brighter, especially in Sagittarius, where the individual stars in the star clouds are so densely packed as to be indistinguishable (not well seen in European latitudes, as they south low in mid-summer). In Argo, near Canopus (50°S.), the Milky Way is (visually) completely divided across for a short distance, but near Canis Major it again becomes a single, though fainter band, which narrows to about 5° in Taurus, and broadens out once more in Perseus and Cassiopeia; its very variable width averages 15°, but in places it is 20° or 30°.

The *Coal Sack*, a remarkable gap (starless to the naked eye) in the Milky Way, near the foot of Crux, appears like a dark abyss in the surrounding brightness—largely due to contrast, as, in a photograph, the area is much brighter than in the non-galactic regions in the vicinity. This gap, similar but smaller gaps in Cygnus and elsewhere, also the Great Rift in Argo, are believed to be due to dark nebulæ (p. 13), intervening between us and the Galaxy beyond.

Stellar Photographs taken on ordinary plates, differ in general from what is seen visually, owing to what may conveniently be termed colour index effect—*i.e.*, stars bluer than A0 being photographically brighter, those redder fainter, than they are visually (p. 16). Such photos show faint B stars bright, and bright M stars faint, making familiar visual groups unrecognisable.

Photographs of the Milky Way (sectional) are given in *H.A.*, vols. 72, 80; others are in *Die Milchstrasse* (Goos), Hamburg 1921, and in *Handbuch der Astrophisik*, vol. 5 (2).

Double Stars are stars which to the naked eye appear as a single point of light, but when viewed through a telescope are found to be composed of two stars—not necessarily physically connected, as they may simply happen to be in the same line of sight. *Triple Stars* have three, *quadruple stars* four, and *multiple stars* many components. Where one of the stars is of a much smaller magnitude than the other, it is often styled a *comes* (plural *comites*) or companion. The most interesting 'doubles,' &c., are indicated in the Notes appended to each star chart.

Binary Stars are double stars which are 'physically connected,' revolving round a common centre of gravity, and not merely chancing to be in the same line of sight. *Spectroscopic Binaries* are those found to be binary by the temporary doubling and displacement of the lines in their spectra, although too close together to be 'resolved,' *i.e.*, seen separate in the telescope. Visible binary stars have periods varying from two years to many centuries. If the plane of their orbit is in the line of sight from the Earth, they may be seen to approach closer and closer together, and at last appear to the eye as a single point for a considerable period, afterwards opening out again.

In a binary system, the motion of the companion is *direct* when the position angle is increasing in degrees, and *retrograde* when decreasing. The smaller star is sometimes said to be in *periastron* with the principal star, when actually (as distinct from apparently) nearest to it; and in *apoastron* when furthest from it.

Star Clusters are small groups of stars, crowded more or less closely together, which in the telescope are glorious sights (see Notes, Star Charts). *Star Clouds* differ in being portions of the Milky Way itself in which the stars are so closely packed as to appear as a continuous irregular bright cloud: they are most conspicuous in Sagittarius, in which the centre of the Galactic System seems to be situated. Star clusters, proper, are of two kinds .-

Globular Clusters are globe-shaped, densely-packed masses of stars, thinning out rapidly at the edges of the central condensation, then slowly when the distances between individual stars has become considerable; M 13 in Hercules (N.G.C. 6205) is a typical specimen. Over 100 are known,* few nearer the Galactic Plane than about 10°, and all lie in the region between 149° and 41° Galactic longitude, which indicates considerable eccentricity with respect to the Sun. They also occupy a place opposite to the majority of the Spiral nebulæ, being mostly in Ophiuchus and Sagittarius.

Open Clusters have no central condensation, are more or less irregular in form, are often associated with nebulosity, and are most numerous opposite the region in which the Globular clusters predominate. The Præsepe in Cancer exemplifies one type, somewhat resembling an open Globular cluster; the Pleiades, in Taurus, represents another type, an irregular, yet well marked group, the components of which have a common motion.

Moving Clusters or *Star Groups* are not clusters in the ordinary sense, but groups of stars which have evidently some intimate relationship, as they are moving with similar velocities towards the same point on the star sphere. Proctor termed this phenomenon 'star-drift.' The individual stars may be in widely different parts of the star sphere. The best known are the Taurus, Perseus, and Ursa Major groups: the latter includes β, γ, δ, ε, ζ, of Ursa Major, and the apparently unconnected stars δ Leonis, Sirius, β Eridani, β Aurigæ, and α Coronæ Borealis.

The Local Cluster, inferred to exist from the study of parallaxes, magnitudes, &c., is believed to be a bun-shaped aggregation of stars, like a very open Globular cluster, to which our Sun appears to belong, and in which he is situated a little to the north of its central plane, and some distance to one side of its centre. Its central plane is inclined 10°-15° to the plane of the Galaxy, and its stars are relatively near us, compared with the Milky Way, and comparatively close together, while its diameter is of the order of 1000 parsecs, or 3000 light-years. The majority of the brighter B stars seem to belong to this cluster, and according to Shapley its apparent centre is in Carina.

* See List in *H.A.*, Vol. 76, and *H.C.O.* 776.